MACHINERY

Volume 44 NEW YORK, JULY, 1938 Number 11

The Aircraft Industry's Contribution to Mechanical Progress

By CHARLES O. HERB

THE spectacular achievements of aviation continue to challenge the imagination. Before this summer ends, huge air liners capable of carrying seventy-five passengers, a crew of ten, and five and one-half tons of cargo are expected to establish non-stop transatlantic flying schedules between the United States and Europe. Already the Clipper planes which started regular service in 1937 between the Pacific Coast and China have carried several thousand persons over millions of miles of sea with the punctuality of ocean liners. In a month or two, it will be possible to circumnavigate the entire world in airplanes operated on regular schedules.

More than a million persons now travel by air yearly within the borders of the United States alone, and more than 18,000,000 pounds of freight are transported annually. The constantly increasing importance of aircraft in modern warfare has led to notable developments in army and navy planes and to greatly expanded airplane building programs by the various nations. The popularity of aircraft over land and sea has culminated in the busiest year so far in airplane construction. It has

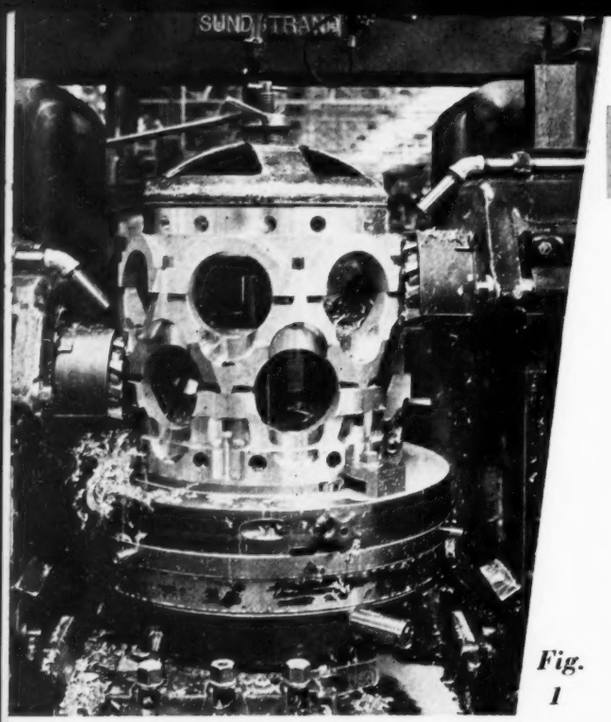


Fig. 1

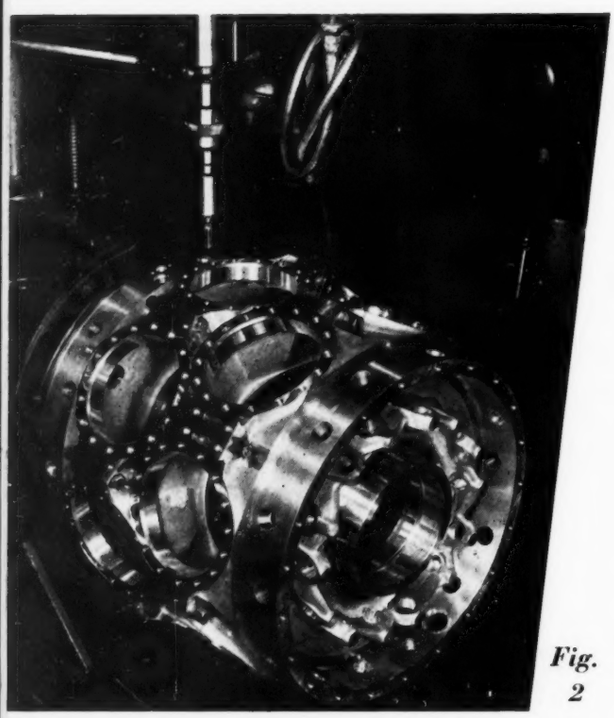


Fig. 2

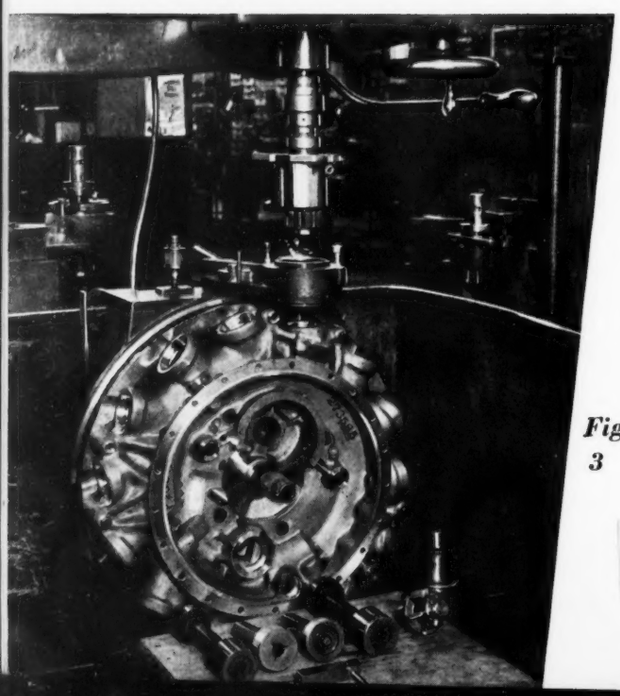


Fig. 3

been estimated by the Aeronautical Chamber of Commerce in America that the total output of the airplane industry in this country during the fiscal year ended June 30 amounted to approximately $158,000,000.

This being the greatest year in the history of airplane building, MACHINERY considers it timely to place on record some of the advanced manufacturing methods of outstanding plants engaged in the production of engines, propellers, instruments, and planes. After all, the spectacular accomplishments in the air have been made possible only through the ingenuity and progressiveness of the airplane building industry and of the suppliers of materials, machine tools, and other equipment. Without the high-strength and light-weight materials developed within the last few years, the huge modern planes of today would not be feasible. And it is the machine tool that makes possible the high accuracy demanded of engine, propeller, and instrument parts. Riveting and welding equipment are just as essential in fabricating the all-metal planes in practically universal use today.

The first article will describe a large number of operations performed in manufacturing the world-renowned "Wasp" and "Hornet" single- and twin-row types of air-cooled, radial engines built by the Pratt & Whitney Aircraft Division of the United Aircraft Corporation at East Hartford, Conn. These engines are built in two general types with single and double rows of cylinders and in capacities up to 1400 horsepower. One of the most important requirements in building airplane engines that is not a factor in any other field of manufacture is that the parts must be of the least possible weight consistent with the strength required. While automobile engines have a dry weight of from 3 to 5 pounds per horsepower developed, to which must be added the weight of the cooling system, an air-cooled airplane engine of the double-row type will have a dry weight of only from 1.1 to 1.2 pounds per horsepower.

Another important factor in building airplane engines is that every engine must be absolutely reliable when it leaves the plant. After each engine has been assembled, it is run in a test house from eight to thirteen hours. Then the engine is completely disassembled and each part is minutely inspected for defects or signs of excessive stress that may have developed during this initial running. The engine is now reassembled and again run from five to twelve hours to determine certain characteristics before it is certified as a dependable unit for the important duty of carrying human lives thousands of feet above land or sea.

Double-row engines are provided with a crankcase built up as shown in Fig. 1, from three of the largest and most difficult aluminum forgings produced in this country. In the operation shown, pads for the cylinder barrels are milled simultaneously on opposite sides of the crankcase

by the two cutters of a double-spindle Sundstrand "Rigid-mil." The fixture is indexed seven times in an operation.

Sixteen holes are tapped around each cylinder pad of the crankcase assembly on an American radial drilling machine equipped with an indexing fixture, as illustrated in Fig. 2. All together, there are 224 of these holes, 3/8 inch in diameter and 16 threads per inch of U. S. standard form. These holes are tapped to receive the cylinder barrel hold-down studs. The fixture is locked in each indexed position and the drilling machine head is shifted to locate the tap over the individual holes.

The intake port holes around the aluminum-alloy blower casting are counterbored and tapped on a Morris radial drilling machine arranged as shown in Fig. 3. The counterboring cut is taken in each port hole with the multiple-blade tool seen near the right-hand side of the board in the foreground. Then the tap is mounted on the machine spindle, as shown, for tapping the holes to a depth of about 5/8 inch, with 2 3/4-inch diameter threads, twelve per inch, of U. S. standard form.

Both the counterboring and tapping tools are accurately guided in the fixture bushing by a large-diameter sleeve above the tool. A lead-screw engages a thread in the spindle sleeve to control the lead of the thread. Gages are provided for checking the threads and the diameter and depth of the counterbore.

The intake and exhaust port holes in the aluminum-alloy cylinder heads are completely machined with the part held in the jig shown in Fig. 4, which is mounted on the table of a Carlton radial drilling machine. In this operation, the center distance of the port holes must be held within plus or minus 0.0005 inch.

The tool seen attached to the machine spindle is employed to bore each port hole, face a shoulder at the bottom of the hole, and face the outside surface of the cylinder head adjacent to the port hole. This tool-holder is also equipped with a large ground sleeve which is accurately guided in the overhead bushings of the jig. A collar at the upper end of the sleeve controls the depth of the facing cuts. A groove on the under side of the collar engages the helical key seen on the lug that projects upward from each fixture bushing so as to lock the sleeve during the actual boring.

After the rough-boring cut, the exhaust port hole is finish-bored and its internal shoulder is finish-faced. Then the intake port hole, without a finishing cut, is tapped to a pitch diameter of from 2.4585 to 2.4615 inches, 16 threads per inch of U. S. standard form. These are afterward finished with a hand tap.

The method of grinding the knuckle-pin holes in the master connecting-rod is illustrated in Fig. 5. The holes in the front cheek are made 0.005 inch larger than the ones in the back cheek to permit free passage of the knuckle pins at assembly. All the holes are held within

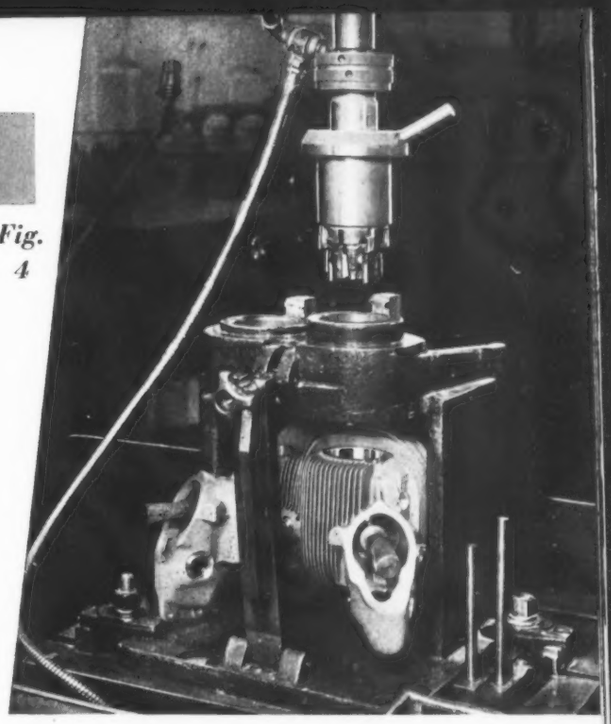


Fig. 4

Fig. 5

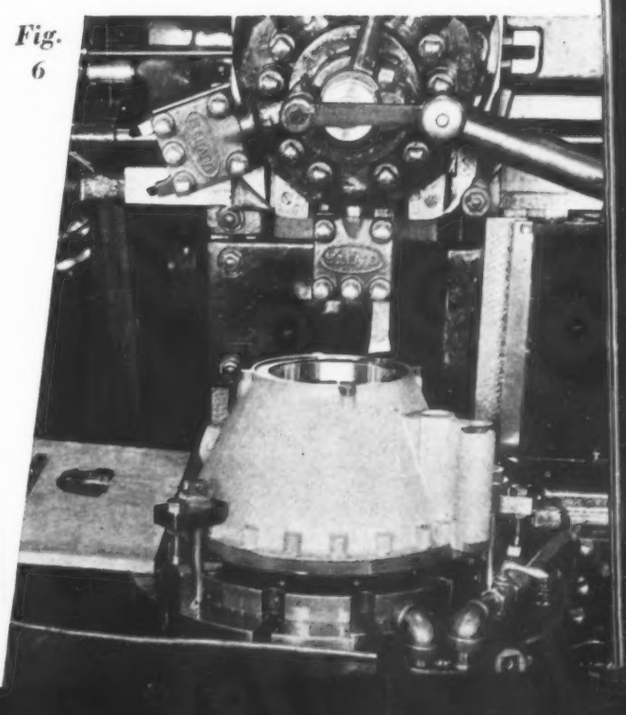


Fig. 6

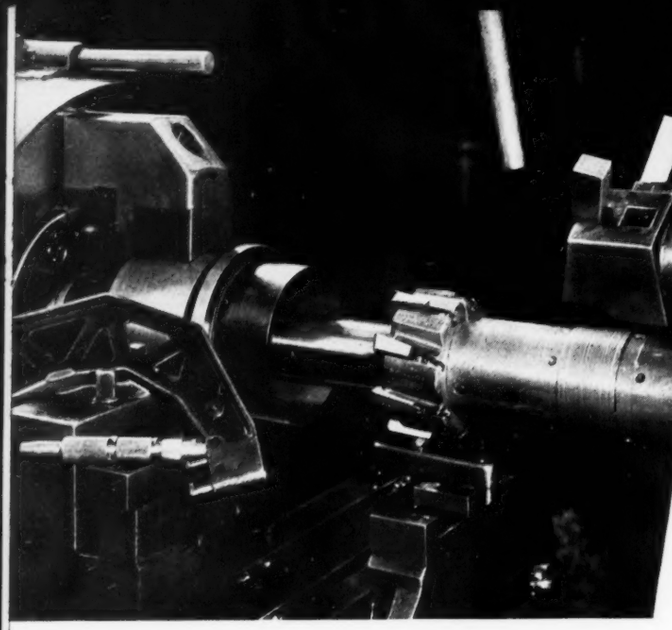


Fig. 7

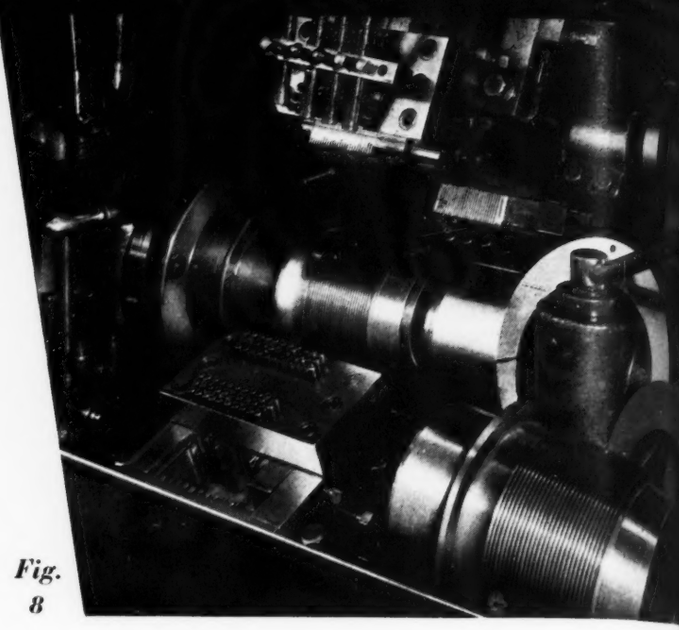


Fig. 8

a total tolerance of 0.0003 inch and the pairs of holes must be absolutely in line. To insure straight holes, traverse of the spindle is held to a minimum by grinding first through the front cheek and then through the back, the 0.005 inch larger diameter in front being controlled by a stepped guide bar.

For this operation, the master rod is loaded on a fixture which is located on a plug extending from the center of the faceplate, there being six holes in the fixture to provide for locating it to suit the grinding of the six pairs of knuckle-pin holes. The machine used is a Bryant chucking grinder.

An unusual operation on one end of the cast-aluminum reduction gear housing is performed on a Bullard vertical turret lathe set up as shown in Fig. 6. This consists of boring the hole, counterboring to the larger diameter, facing the narrow rim and the wider shoulder, back-facing the under side of the section through which the hole extends, and chamfering the upper edge of the hole. The facing cuts are taken by feeding the tool turret sidewise after the tools have been correctly positioned, the boring cuts being performed, of course, by feeding the tools vertically.

Exacting operations are required on the cylinder barrels. These parts are forgings of Nitralloy, received at the plant in a rough-turned condition. A typical cylinder barrel forging weighs 33 pounds when received and only 7.8 pounds when finished, over 75 per cent of the metal having been cut away during the machining process. The first operation consists of taking a truing cut on one end of the cylinder barrel in an ordinary lathe, after which the barrel is bored the full length in the Potter &

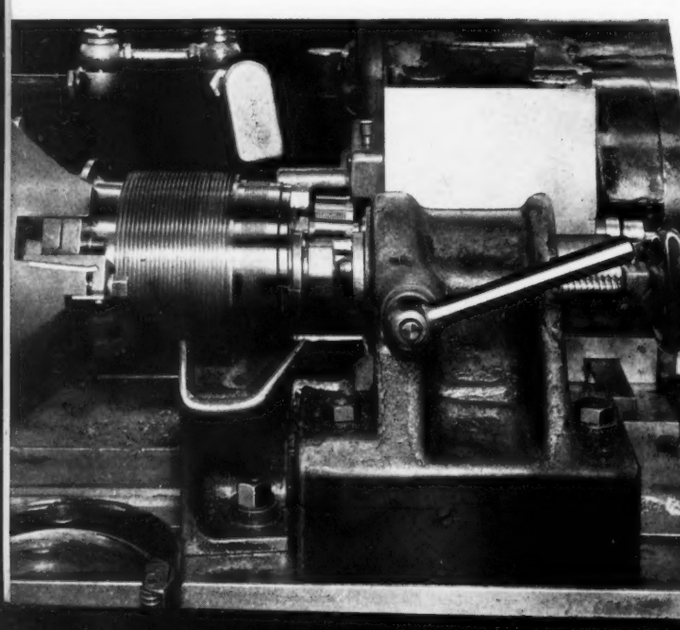


Fig. 9

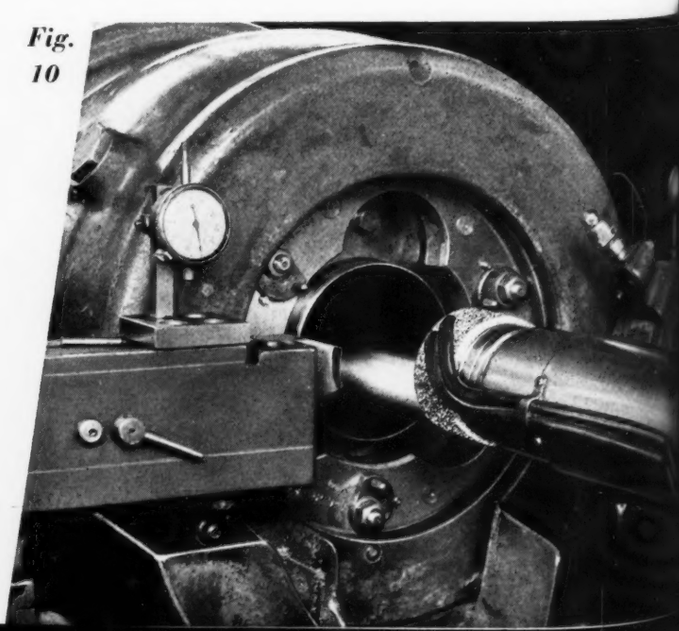


Fig. 10

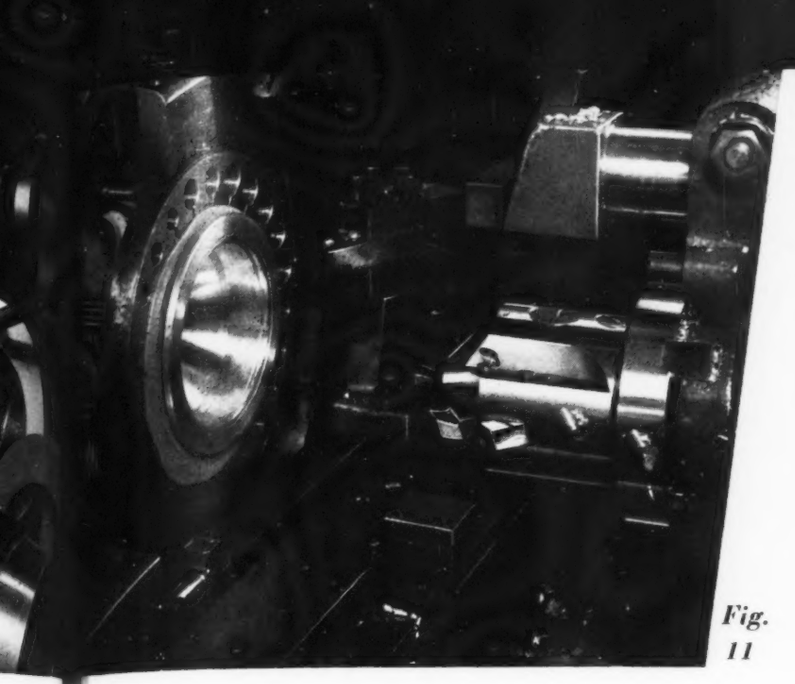


Fig. 11

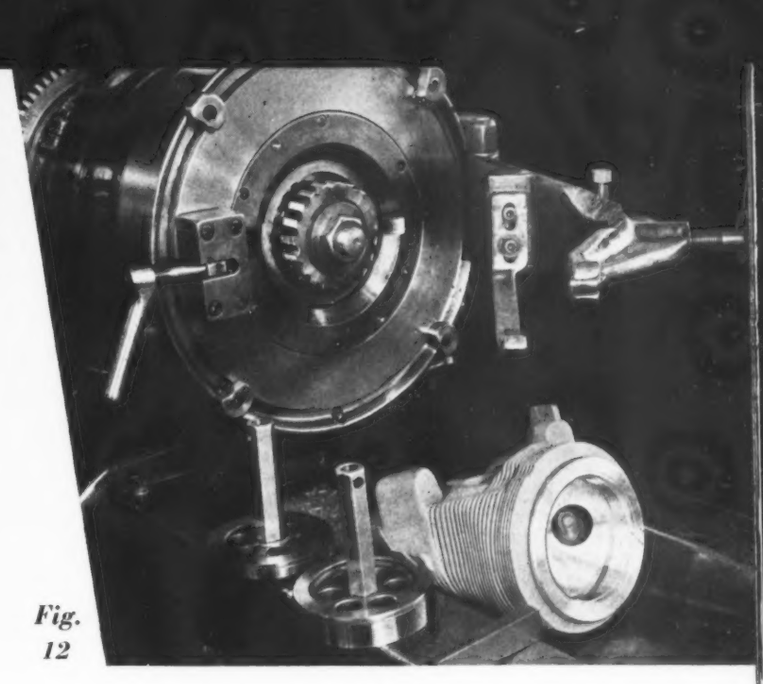


Fig. 12

PRATT & WHITNEY ENGINE BUILDING

Johnston automatic chucking machine illustrated in Fig. 7. At the same time, the barrel is turned and faced on one end and also on the flange. After several minor operations, the remaining outside surfaces are turned and faced in a Fay automatic.

All surfaces of the barrel that are to be left soft after the nitriding process for subsequent machining are protected by electroplating with tin to a suitable thickness. In the electroplating, tin is also deposited in the bore and must be removed in order to expose the bore to the nitriding gas. This is done by grinding the bore in a Bryant or Heald cylinder grinder. The barrels are then thoroughly cleaned and transported to the heat-treating department, where they are loaded, 150 at a time, into Westinghouse bell type nitriding furnaces.

One of the most unusual operations on the cylinder barrel following nitriding is the machining of the twenty-six fins, which is performed in a Fay automatic lathe, as shown in Fig. 8. Three complete sets of tools are provided. One set cuts away the metal between the fins, and the other two sets machine the sides of the fins to the required thickness. These fins are only 0.020 inch thick at the top and taper to 1/32 inch at the bottom.

Another operation on the cylinder barrel is to machine a thread on which the cylinder head is later shrunk. This is done in the Hanson-Whitney thread miller shown in Fig. 9. The threads, eight per inch, must be milled to a pitch diameter of from 5.786 to 5.790 inches, a tolerance of 0.004 inch.

The final grinding operation in the cylinder barrel bore is performed on Heald and Bryant grinding machines, as shown in Fig. 10. The thinness

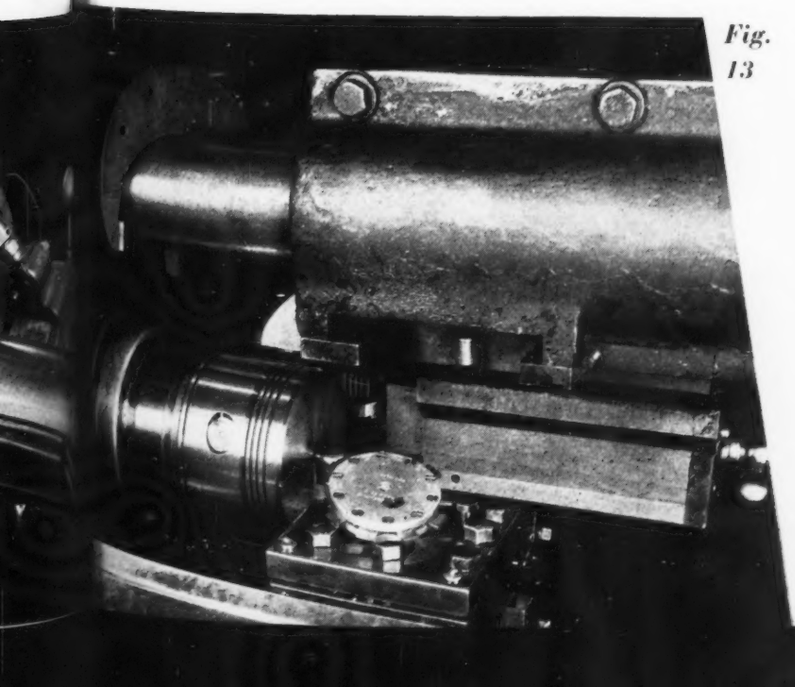


Fig. 13

Fig. 14

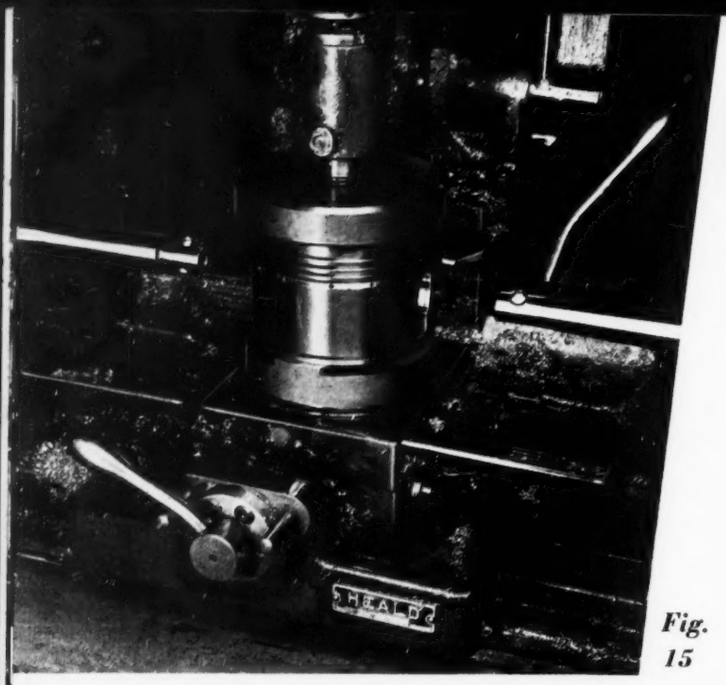


Fig. 15

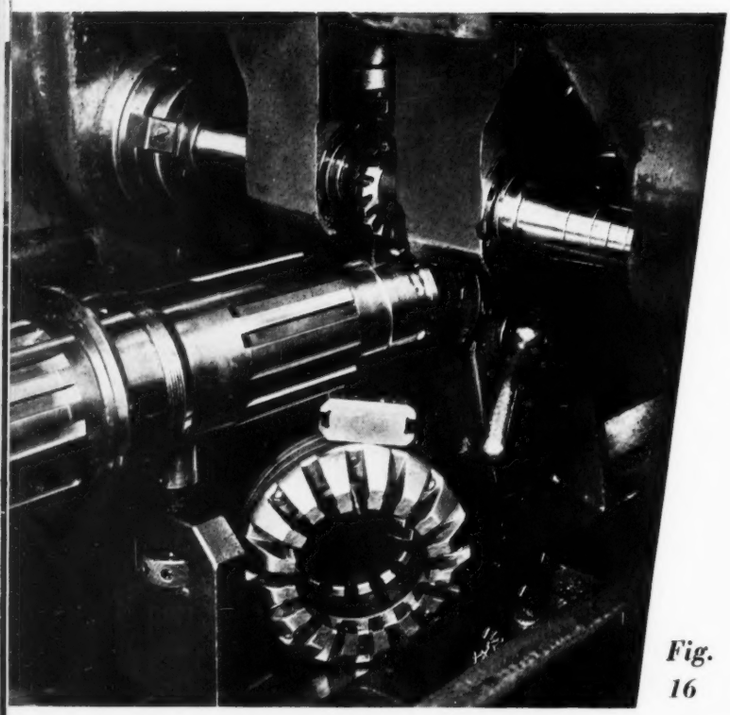


Fig. 16

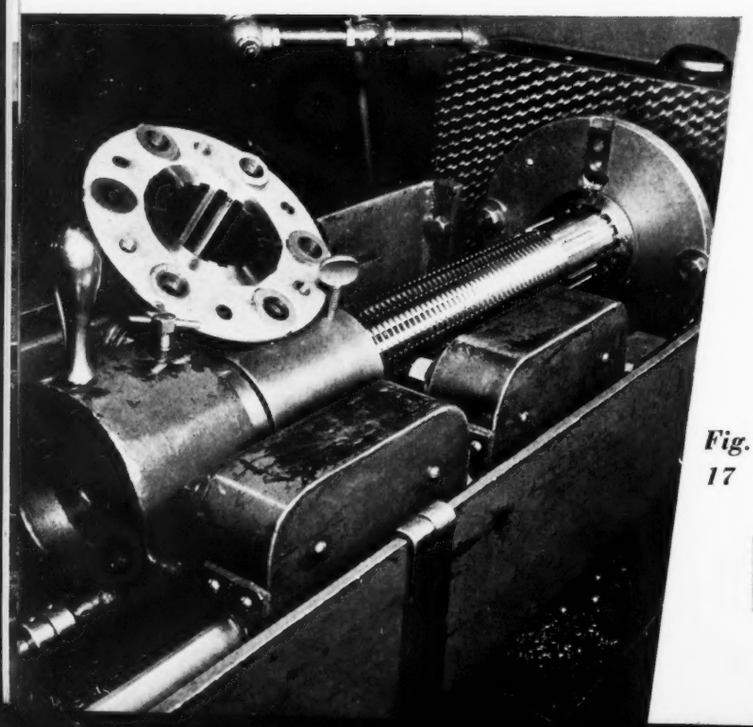


Fig. 17

of the barrel wall as this part reaches completion is apparent in the illustration. On a typical barrel, the bore diameter must be 5.500 inches within plus or minus 0.001 inch, and the outside diameter at one end, only 5.680 inches within plus or minus 0.002 inch. This permits a maximum wall thickness at that end of only 0.0915 inch.

One of the unusual operations on the cylinder head consists of finishing the spherical inside of the dome. This is done on the Potter & Johnston chucking machine shown in Fig. 11, which also counterbores the surface on which threads are later machined to match those on the cylinder barrel. During this operation, facing cuts are taken on the flange and on the internal shoulders, and the flange is turned. The spherical dome surface is finished by pivoting tools on the turret, which are swung through the required arc by the action of a rack and pinion, after the tool has been advanced into the cylinder head.

The threads in the cylinder head which are shrunk on those of the cylinder barrel are cut in the Hall Planetary machine shown in Fig. 12. These threads are milled to a pitch diameter of from 5.774 to 5.778 inches on the head shown, leaving a shrinkage fit of from 0.012 to 0.016 inch on the threads of the barrel. The thread-milling cutter is provided with wide teeth on the inner end for finishing the plain shrink surface in back of the cylinder head threads.

Pistons are finish-turned, finish-faced, and grooved in a Sundstrand stub lathe set up as illustrated in Fig. 13. Tools tipped with tungsten carbide are used for machining these aluminum forgings, the grooving tools being mounted at the rear and the turning tool in front. The grooves are machined to five different widths ranging from 0.097 to 0.2215 inch, within limits of plus or minus 0.0005 inch. On the front tool-block may be seen the gage for the piston grooves. "Go" and "No Go" blades are provided for each groove.

Fins to aid heat radiation are machined on the inside of each piston, on opposite sides, in a Kearney & Trecker vertical-spindle milling machine, as illustrated in Fig. 14. The tool used for this operation is built up from the required number of single milling cutters. It is fed vertically to the required position and then sidewise to depth, after which the fixture is rotated through about one-fourth of a revolution to cut the fins on one side.

The wrist-pin holes of a typical piston are held to 1.3729 inches diameter, within plus 0.00035 minus 0.00025 inch, a tolerance of only 0.0006 inch

being allowed. Boring to this accuracy and to the high degree of smoothness required is accomplished by a Heald "Bore-Matic," set up as shown in Fig. 15. Close alignment of the holes is insured by first taking a boring cut through both holes with a tungsten-carbide tipped tool mounted on the left-hand head of the machine. Then a diamond tool on the right-hand head is fed through the two holes.

Splines are accurately milled on propeller shafts by the use of a Brown & Sharpe milling machine, as shown in Fig. 16. A large indexing plate insures accurate spacing from spline to spline. This spacing is checked by the gage seen on the table of the machine, which has a series of fingers that must enter the grooves between all the splines at one time. The accuracy of the spline thickness is determined by the "Go" and "No Go" snap gage shown. Typical limits on this dimension are plus 0.0005 inch, minus 0.0005 inch.

Straight splines are broached in the reduction gear hubs to match the splines of the propeller shaft by employing the Lapointe hydraulically operated machine shown in Fig. 17. A rough broach is first passed through a quantity of hubs, after which the finishing broach shown is used.

The channels in the arms of the master and articulated rods are machined in solid stock by the use of end-mills, as illustrated in Fig. 18, where four rods are shown being milled simultaneously on a special Milwaukee milling machine. Two rods are rough-milled by spindles on the right-hand side of the machine (not visible in the illustration), and two are finish-milled by the cutters in the foreground. Sometimes two finish-milling operations are necessary to bring the rods to the correct weight, which is generally held to a tolerance of 0.02 pound.

The teeth of all spur gears in the speed reduction unit are finish-ground. Fig. 19 shows the finishing of two pinions on a Pratt & Whitney generating grinder, in which the shape of the involute teeth is controlled by means of a master gear and rack.

The grinding of two rows of teeth in the large internal gear of the speed reduction unit is performed as illustrated in Fig. 20 on a machine built by the Gear Grinding Machine Co. The wheel is dressed to the profiles of two adjacent teeth, so that the sides of two teeth are finished as the wheel is reciprocated across the gear. The practice is to take several rough-grinding cuts around the gear and then a finish-grinding cut. The wheel is dressed several times during rough-grinding and also prior to finish-grinding.

Fig. 18

Fig. 19

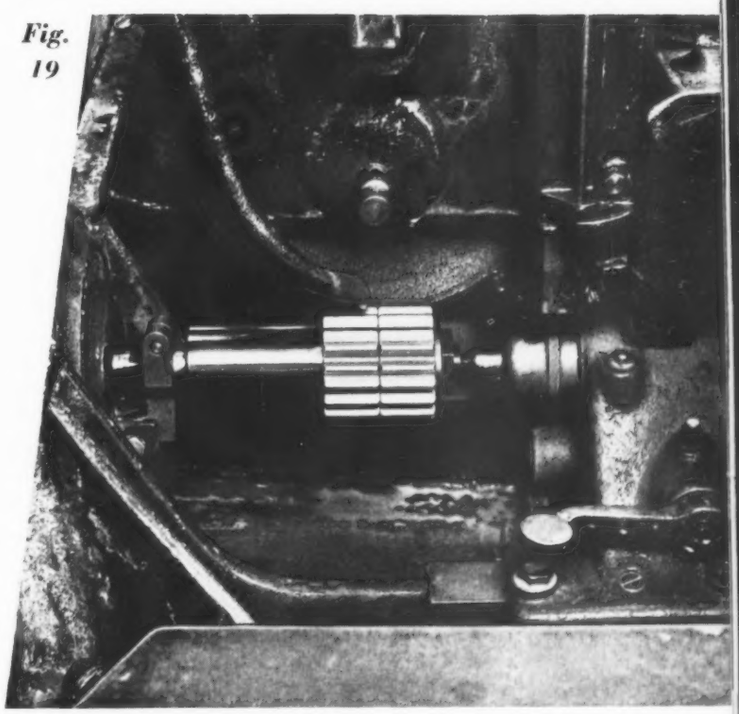
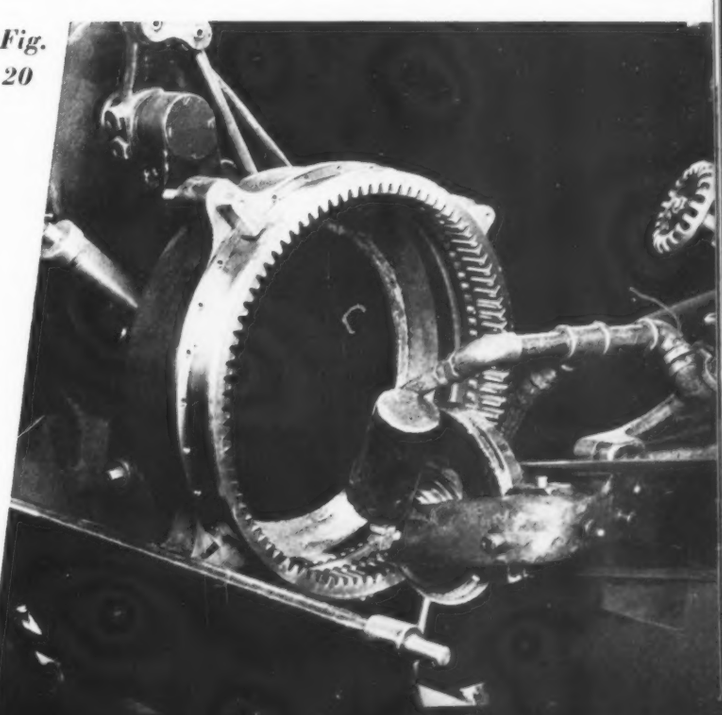
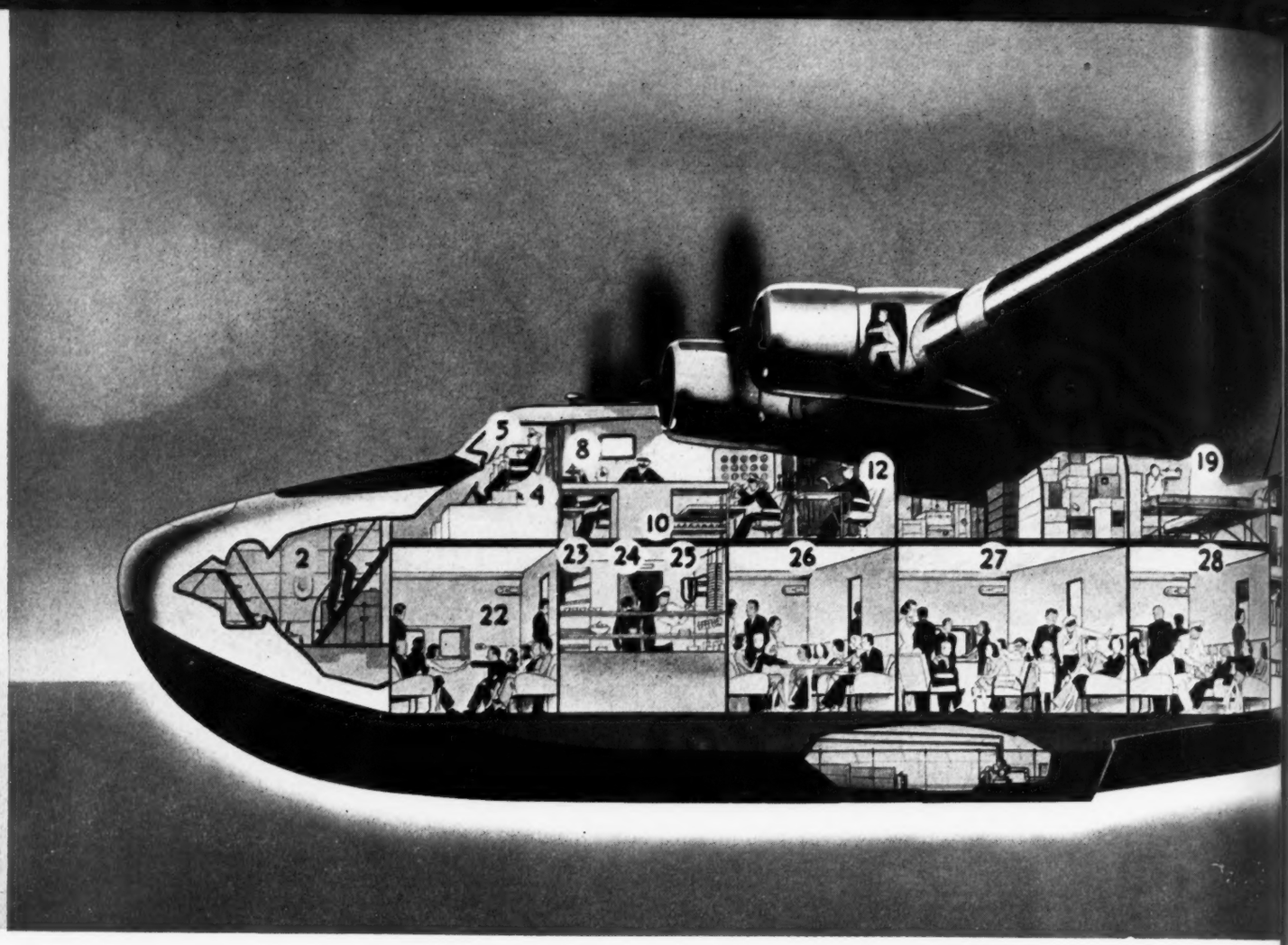


Fig. 20



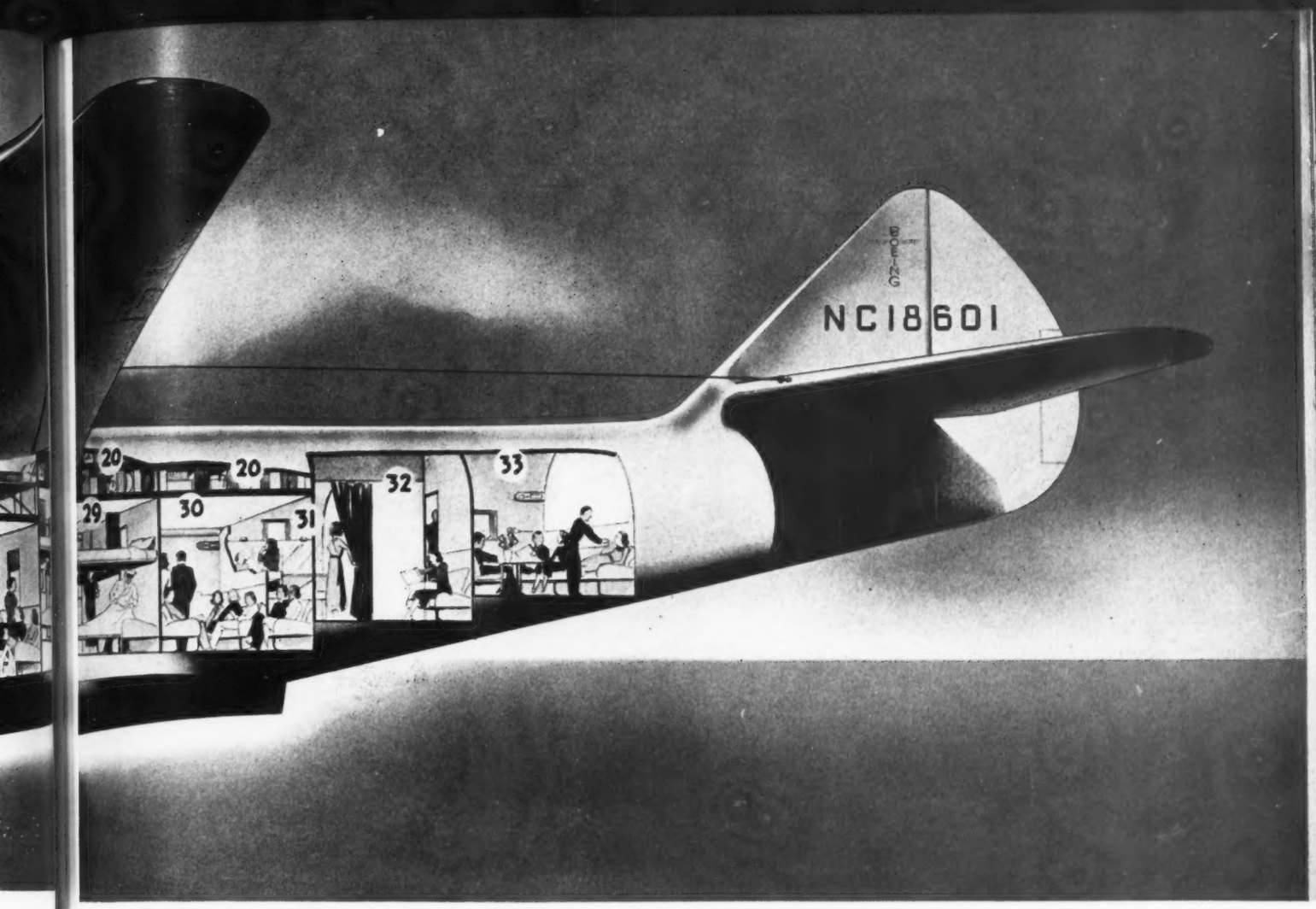


Building Flying Boats

THE engineering ability and mechanical ingenuity of the airplane-building industry have reached an all-time high point with the development of the huge flying boats that will soon be maintaining regular schedules across the Atlantic and Pacific Oceans. These airplanes, which will be operated by the Pan American Airways, will accommodate fifty passengers on transoceanic flights and seventy-five passengers on shorter routes, in addition to a crew of ten.

The planes are actually larger than the ships in which Columbus sailed to America. They have a wing spread from tip to tip of 152 feet, a hull 109 feet long, and a weight of 41 tons. The weight is three and a half times that of the largest overland airliner now in service in America. Each plane will be driven by four of the most powerful radial air-cooled engines yet to be developed—fourteen-cylinder Wright "Cyclones" of double-row type with a take-off rating of 1500 horsepower each. Two of these engines, which are less than 5 feet in diameter, are powerful enough to drive the plane in the air.

These planes have a capacity for more than 10,000 pounds of air mail and freight, in addition to the passenger accommodations, and for over 4200 gallons of gasoline, which will be carried in tanks within the wings and sponsons. The planes have a speed range up to 200 miles an hour when loaded, and a cruising range of 4000 miles with forty passengers. Some of the accommodations on these huge Pan American Clippers can be seen by reference to the heading illustration, where numbers are used to designate the different compartments: (2) Seaman's compartment; (4) and (5) pilot rooms; (8) radio room; (10) chart room; (12) captain's office; (19) crew's sleeping quarters; (20) luggage holds; (22), (26), (28), (29),



Bigger than Columbus' Ships

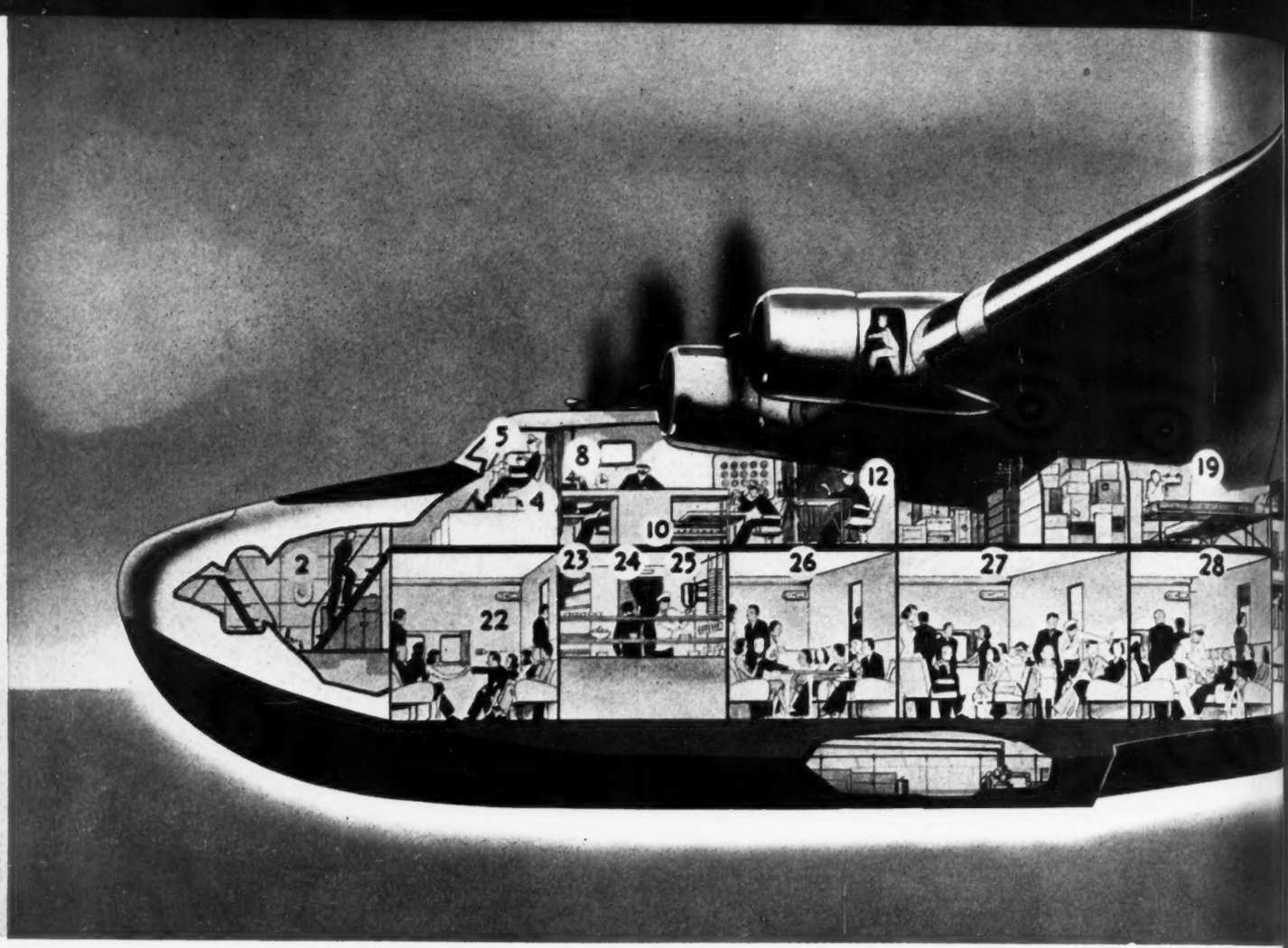
(30), and (32) passengers' compartments; (27) dining lounge; and (33) private cabin suite.

Six of these planes were ordered from the Boeing Aircraft Co., Seattle, Wash., and the photographs here shown were all taken in the plant of that concern. These illustrations demonstrate that the building of airplanes is today completely within the sphere of the metal-working industry. Whereas the "crates" of the early days of aviation were constructed principally of wood and fabric, there is hardly enough wood on a modern plane to make a box of matches.

More than 6000 engineering drawings were required for the building of these planes. Alcoa aluminum alloy has been largely used for the framework, although the main members of the center-section bulkheads are built up of steel. Tubular members in the center-section bulkheads and in the central wing-spar structure are of chromium-molybdenum steel, and spar terminals are of chromium-nickel-molybdenum steel. The covering of the hull, wings, etc., is entirely sheet aluminum.

Almost a million aluminum alloy rivets were needed for assembling the structural members of each plane, and there are about 11 1/2 miles of electrical wiring, 3000 feet of piping, and 5000 feet of control cable on each plane. Spot-welding was used for seaming together sheets of aluminum alloy for wing covering and was also used on numerous non-structural parts. Autogenous welding was used on aluminum fuel tanks, aluminum tubing for furniture, Inconel and stainless steel exhaust stacks, and also on some steel fittings. Arc-welding was used on engine mounts and fittings of S A E X-4130 steel.

The procedure in building these large flying boats is more nearly allied to shipbuilding than to airplane building. Hull assembly is accomplished in



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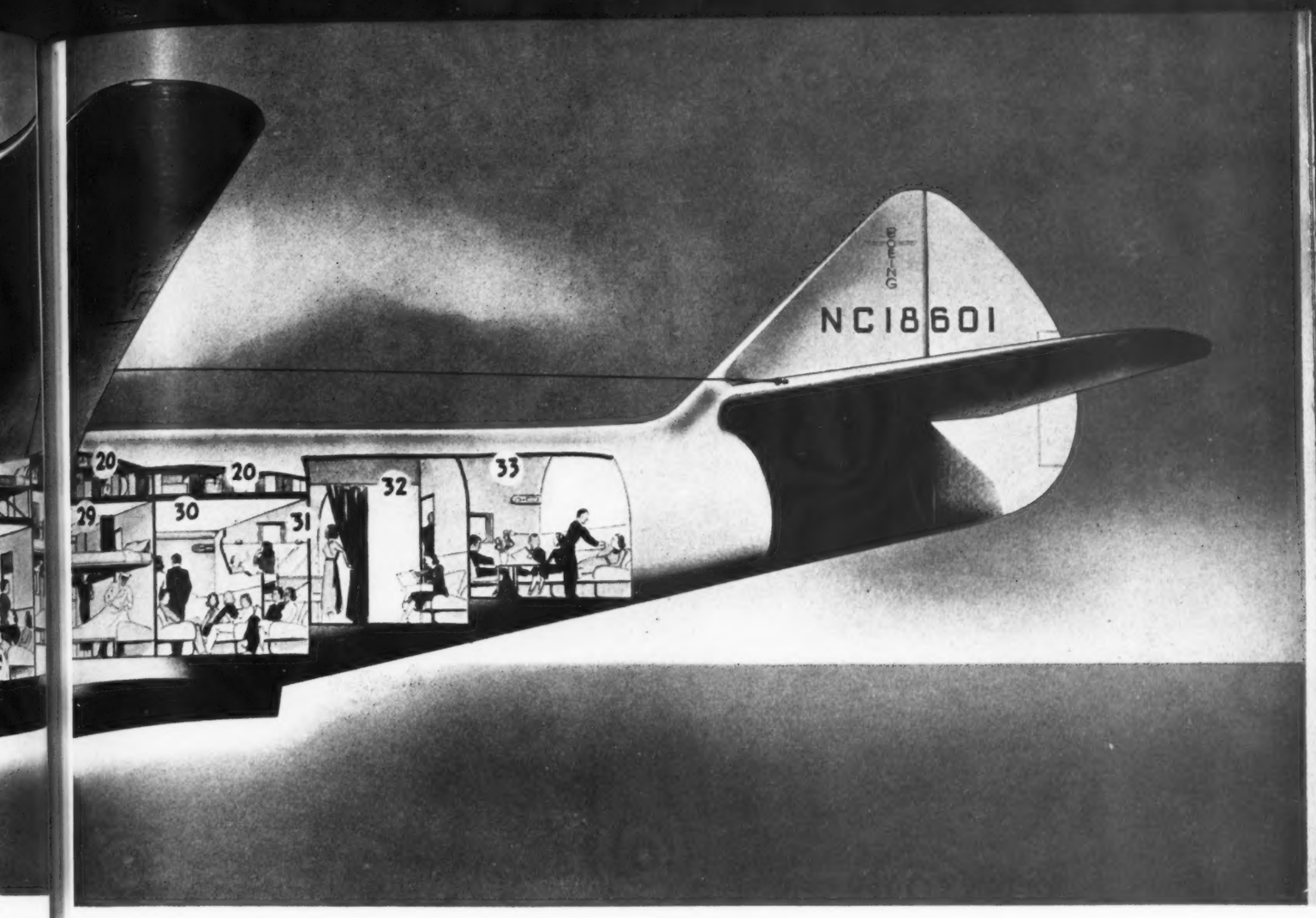

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Almost a million aluminum alloy rivets were needed for assembling the structural members of each plane, and there are about 11 1/2 miles of electrical wiring, 3000 feet of piping, and 5000 feet of control cable on each plane. Spot-welding was used for seaming together sheets of aluminum alloy for wing covering and was also used on numerous non-structural parts. Autogenous welding was used on aluminum fuel tanks, aluminum tubing for furniture, Inconel and stainless steel exhaust stacks, and also on some steel fittings. Arc-welding was used on engine mounts and fittings of S A E X-4130 steel.

The procedure in building these large flying boats is more nearly allied to shipbuilding than to airplane building. Hull assembly is accomplished in

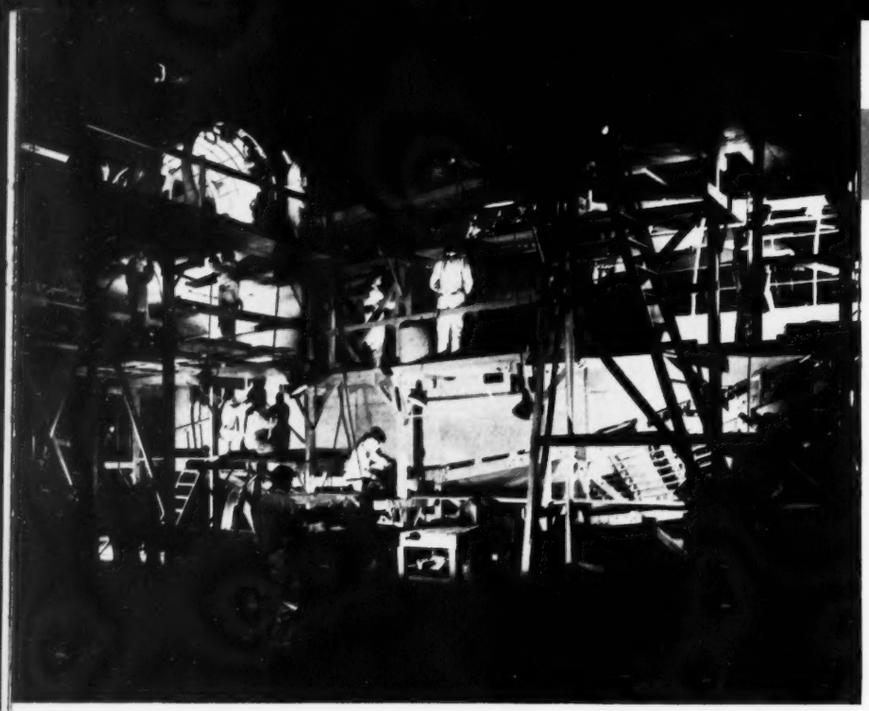


Fig. 1. The Assembly Jig, in which the Huge Hulls are Put Together, is 115 Feet Long, 26 Feet High, and 36 Feet Wide in the Center. Scaffolding Enables the Men to Work at Five Different Levels

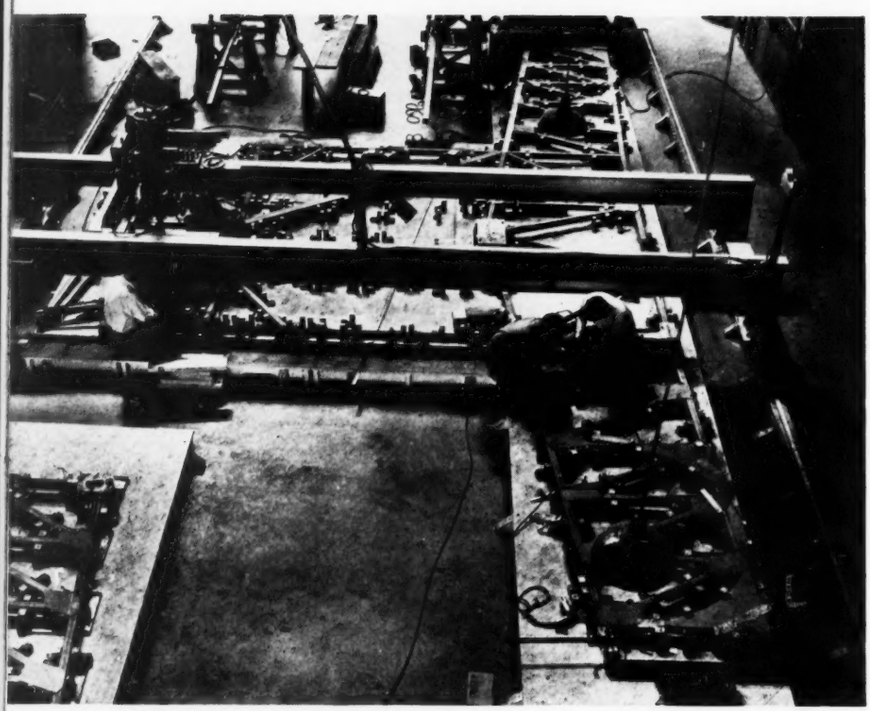


Fig. 2. A Traveling Drill Facilitates Drilling Various Rivet Holes in Assembling the Frame Members—in This Case, One of the Center-section Bulkheads

Fig. 3. Wooden Jigs Insure the Accurate Sub-assembly of the Various Sections. This Illustration Shows a Jig Used in Fabricating the Truss Type Wing Spar and a Wing Spar that is Practically Completed

a huge jig that might be compared with a drydock, and scaffolding is erected outside of the jig, which enables men to work at five different levels. There are two of these "docks," set in steel and concrete, to permit assembly operations on two planes at a time. Each one of these jigs is 115 feet long, 26 feet high, and 36 feet wide in the center.

Fig. 1 shows the forward end of a hull in one of these assembly jigs. For the final assembly of the hulls, wings, tail surfaces, etc., there is an outdoor "dock" of similar proportions, connected to a ramp leading into the water. The completed flying boats slide down ways like ships, in being launched.

Wooden jigs of the type seen in the left foreground of Fig. 3 insure accurate riveting together of the structural members in the various sub-assemblies of the frame. This illustration shows a jig for a wing spar and also a spar practically completed. Other jigs may be seen behind the spar.

On certain sub-assemblies, holes for rivets are quickly drilled in true vertical planes by the use of the equipment shown in Fig. 2. This consists of a motor-driven drill head mounted on a low "crane" which travels on rails fastened to the floor.

Riveting is largely performed by the use of portable electric and pneumatic hammers, as illustrated in Fig. 4, where aluminum sheets are shown being attached to the tail stabilizer. The sheets that cover the stabilizer, wings, and hull range in thickness from 0.016 to 0.064 inch.

In Fig. 6 two workmen are seen constructing one of the nacelles for the engines. Four of these nacelles are mounted on the wings of each plane, and they are accessible through companionways in the wings when the plane is in flight. Each nacelle is as large as the fuselage of many smaller planes.

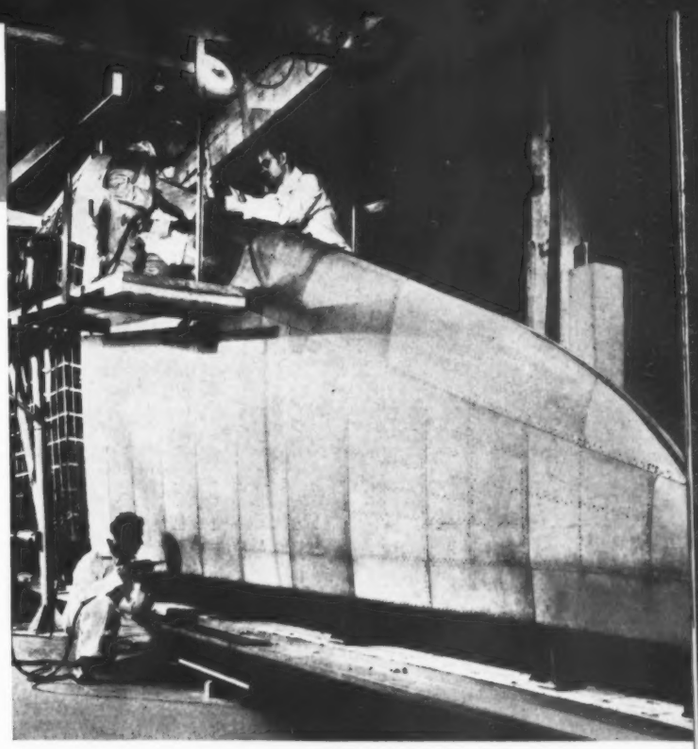


Fig. 4. (Upper Right) Completing the "Tail Feathers" for a Boeing Clipper. The Stabilizer Here Shown Measures About 49 Feet from Tip to Tip

Fig. 5. (Middle Right) Sheets of Aluminum Alloy being Seamed Together by the Electric Spot-welding Process to Form the Wing Skin

Fig. 6. (Lower Right) Workmen Riveting on the Inside of One of the Large Nacelles that will House the 1500-horsepower Wright "Cyclone" Engines

Feathering

Airplane in Flight with One Propeller Rotating and the Other "Feathered"

THE propellers of airplane engines running under full throttle have a speed at the blade tips approximately the same as the velocity of sound. At this terrific speed the slightest amount of unbalance in the propeller unit can set up sufficient vibration in the airplane to cause discomfort and unsafe flying conditions.

In making propellers, therefore, great care has to be taken to secure the highest degree of balance, and the manufacturing methods developed by the Curtiss Propeller Division of the Curtiss-Wright Corporation, Buffalo, N. Y., have made it possible to produce propellers within balance to an amazing degree of accuracy. When tested on a balancing stand, these propellers will remain stationary in every position to which they may be turned, even though a cigarette paper placed on the tip of a blade would have sufficient weight to cause perceptible movement of the blade. Care is taken to keep flies from lighting on the propeller during an inspection, and the inspectors must even avoid breathing against the blades. Static balance of propeller blades has proved satisfactory for all practical purposes.

Balance, however, is only one of the important requirements in propeller manufacture. The dimensions and angles of the sections at various points along the blade must be held to extremely close tolerances, considering the thinness of the sections and the length of the blade. Close tolerances are also specified on all hub parts. How these requirements are met in manufacturing the Curtiss full-feathering automatic controllable-pitch propellers will be described in the following.

The distinctive feature of these feathering propellers is that on twin or multiple engine airplanes, if it becomes desirable to shut off one or more engines during flight, the propeller blades of the engine that has been stopped may be "feathered," so that their leading edges are brought directly toward the line of flight. The propeller then remains stationary as the plane continues in flight, instead of acting like a windmill, cranking the engine and creating undesirable drag, vibration, etc., that would produce adverse flying conditions. This principle is illustrated in the heading, which shows one of the propellers completely stopped while the other is maintaining flight.

Because the propeller can be completely stopped, excessive damage to engine parts is avoided when it becomes necessary to shut down an engine having a broken connecting-rod, cylinder head, or other

Fig. 1. Propeller Blades Must be Checked for Accuracy of Angles and Dimensions Every 6 Inches of Their Length Several Times During the Manufacturing Process

Propellers with "Cigarette Paper" Balance

important part. There are additional advantages resulting from the fact that a propeller can be completely stopped, including the ability to attain higher altitudes in approaching mountain ranges and other obstructions than would otherwise be possible with one or more engines shut down. Feathering propellers may enable a flying boat with a crippled engine to return to a port without the necessity of landing in mid-ocean.

The constant-speed feature of these propellers provides for the automatic swiveling of the blades in the hub sockets in order to increase or decrease the blade pitch to compensate for changing loads on the engine. Thus, an airplane engine equipped with a constant-speed propeller can be operated at any desired constant speed regardless of periodic changes in the load caused by climbing, diving, or rough air. The swiveling of the propeller blades to change the pitch is accomplished by an electric motor mounted on the nose of the hub and connected through a planetary gear reducer to the base of each blade. A governor, driven by the engine, throws switches which adjust the blade angles to hold the speed constant.

Propeller blades are received at the Curtiss-Wright plant in the form of rough aluminum-alloy forgings. Before being machined, the blades are carefully inspected for quality of material, thickness at various points, and correctness of the angles of the flat side. It is frequently necessary to twist the forgings approximately to the correct angles in order to insure that there will be sufficient stock for machining the blades all over.

This inspection of forgings is performed on tables of the type seen in Fig. 1, which have an accurate line running the full length from the center of the fixture in which the propeller blades are mounted. Every 6 inches from this fixture there is a line on the table running at right angles to the longitudinal line. Each blade must be checked for thickness and angle at these "stations," as they are called, and in fact, lines are scribed across the blades themselves at these stations by means of height gages before, as well as after, rough-machining. A special Brown & Sharpe protractor is being used in Fig. 1.

The first machine operation on a propeller blade consists of taking turning and facing cuts on the

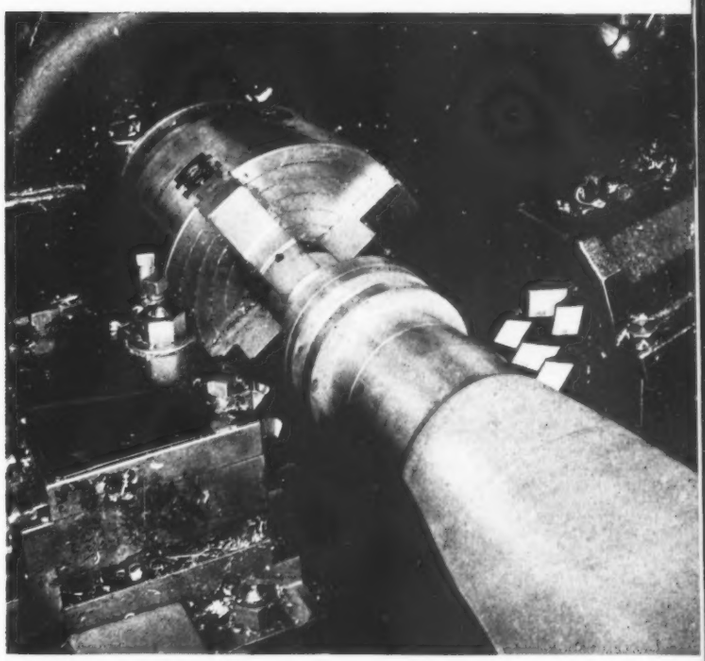


Fig. 2. The Hub End of Propeller Blades is Rough- and Finish-machined in One Operation in an Unusual Lathe Set-up; Two Sets of Tools are Provided on Both Front and Rear Cross-slides

Fig. 3. Both Sides of the Blades are Rough-machined in a Berliner Profiling Machine; the Revolving Cutter-head Takes Cuts on Both Forward and Return Strokes

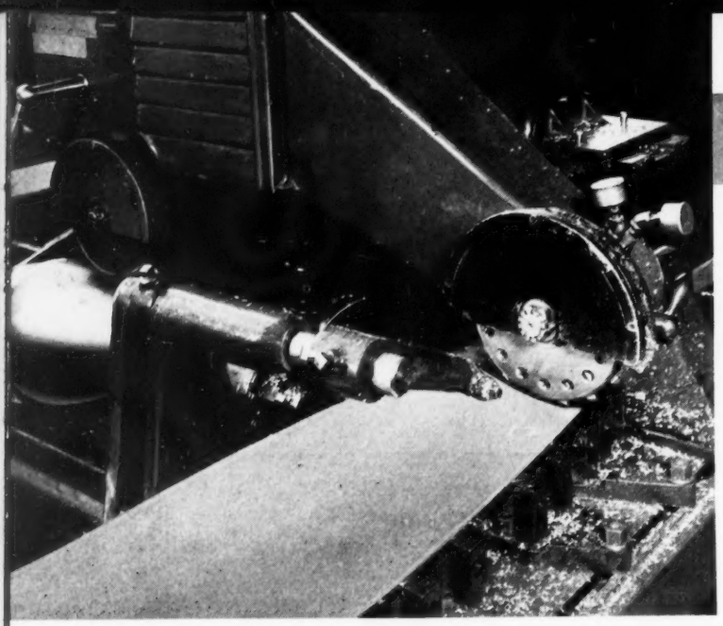


Fig. 4. Close-up View of the Cutter-head and Cam by Means of which the Constantly Changing Profile of the Propeller Blade is Machined to Meet Requirements

Fig. 5. (Left) Continuous-belt Sanding Equipment which Removes All Cross Grinding Marks after Rotary Sanding

Fig. 6. (Right) The Blades are Finally Given a High Polish and are Then Ready for Use or for the Anodizing Process

hub end as illustrated in Fig. 2, which shows this work being performed in a Lodge & Shipley lathe. This lathe is equipped with two sets of tools on both front and rear cross-slides. The tools in the upper set of the front slide are set for the rough-turning operation by the individual holders being pushed forward and locked through the engagement of eccentric collars with grooves on the front side of the slide. The cross-slide is then advanced toward the work by turning a carriage handwheel to a predetermined graduation, after which the lathe carriage is fed toward the headstock for turning three surfaces, the finish-turning tools beneath the roughing tools, of course, clearing the work. As the carriage moves along the bed, the central roughing tool is gradually fed forward by means of a guide, for machining to the required taper.

While these turning cuts are being taken, the two roughing tools at the top of the rear slide are positioned ahead of the bottom finishing tools by turning a crank-handle. Then, when the rough-turning is completed, the rear tool-slide is fed forward to a predetermined handwheel graduation to take rough-facing cuts.

The carriage is next returned to its starting position, the roughing tools on the front and rear slides are moved back, and finishing cuts are then taken on the same propeller blade surfaces with the second sets of tools on the front and rear cross-slides. Upon the completion of the operation, a parting tool on the left-hand side of the front slide cuts away to a diameter of about 3/4 inch the boss by means of which the hub end of the propeller blade is held in the chuck. When the propeller blade is removed from the machine, this boss can then be readily knocked off. All of the tools used in this lathe operation have tantalum-carbide tips. The various surfaces must be machined within limits of plus 0.000 inch minus 0.003 inch, the maximum diameter being 4.995 inches.

"CIGARETTE PAPER" BALANCE

Vibrationless rotation is obtained by supporting the blade about its midpoint in a special steadyrest and by holding the blade tip on a tailstock center. Immediately after this operation, the hub end of the blade is drilled to a diameter of 7/8 inch and a depth of 5 1/2 inches in a second Lodge & Shipley lathe, the drill being held in the tailstock. At the end of the drilling operation, the propeller blade goes back to one of the inspection tables for rechecking the angles, face alignment, and centers.

The propeller blades are next profiled on the Berliner machine illustrated in Fig. 3, which is equipped with a rotating cutter-head fitted with sixteen inserted tool blades, as shown in Fig. 4. This cutter-head is mounted on the front end of a reciprocating arm, which is pivoted on one side so that the cutter-head can be raised and lowered as it passes back and forth over the propeller blade, in order to machine the blade to the constantly changing shape required.

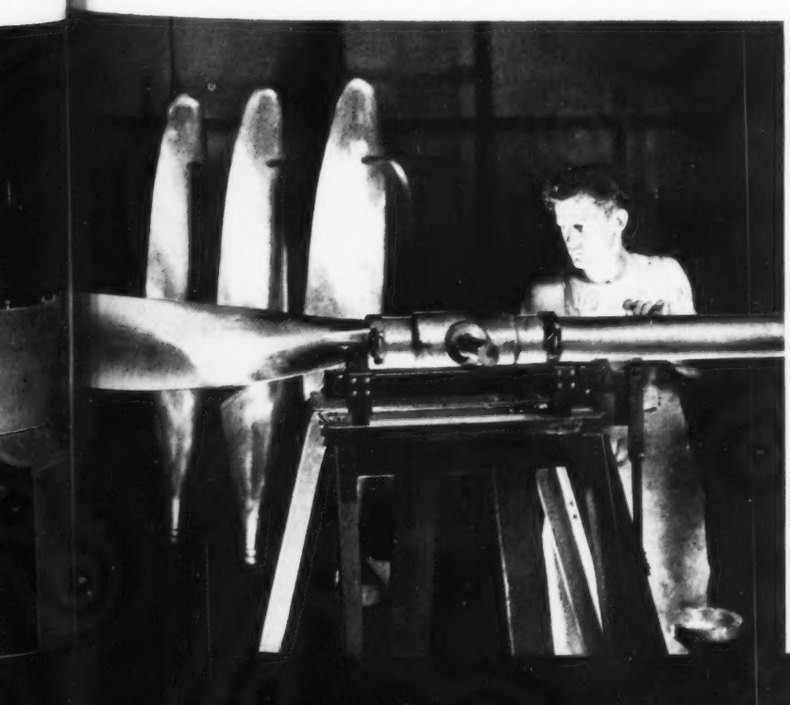
These vertical movements are actuated by the roller seen at the back end of the slide in Fig. 4 as the roller runs back and forth on top of a drum cam. The contour of this cam varies constantly around its periphery and the cam is indexed in synchronism with each indexing of the table. The latter is indexed after each forward and return stroke of the cutter-slide, the cutter taking a cut both when it moves forward across the propeller blade and when it returns. A different drum cam is, of course, required for the face and camber sides of each type of propeller blade.

In this operation, the cutter is driven at about 1250 revolutions per minute, the cut is about 3/32 inch deep, and the feed is 1/8 inch. The previously machined hub end of the propeller blade is held in a suitable fixture, and the tip end is supported on a tailstock center. In addition, there are a number of supporting pins for the under side of the blade which are set to a master blade at the beginning

Fig. 7. Flexible Sanding Disks Driven by a Portable Unit are Used to Gradually Obtain the Desired Finish and Correct Form of the Propeller Blade

Fig. 8. (Left) Each Blade is Statically Balanced to a Master, so that All Blades of a Given Type are Interchangeable

Fig. 9. (Below) The Three Blade Barrels in Propeller Hubs are Accurately Ground by Means of This Equipment



of a job and then clamped in place. Rigidity of the work during each cutting stroke is insured by a roller, which holds the blade firmly on the supporting pins close to the path of the cutter-head. This roller is mounted on the end of an arm by which it is raised from the work for the index movements of the table and lowered firmly on the propeller blade for the actual cutting.

The propeller blades are rough-machined on both sides in the Berliner machine from the tip end to the station that is 18 inches from the other end. It is interesting to note that the drum cams used on this machine are finished by the same machine. In forming a cam, a master propeller blade is mounted on the table and a roller is substituted for the cutter-head. Then a cutter-head is substituted for the cam roller and a roughly formed block of steel is mounted on the cam-drum arbor. When the head of the machine is reciprocated back and forth and the drum is indexed in synchronism with the table, a cam of the necessary contour is developed for use in machining propeller blades identical to the master. Extreme accuracy is necessary in developing the cam and in setting it up in the machine.

At the end of the Berliner profiling operation, the propeller blades are returned to one of the inspection tables and grooves are filed by hand in the 12-inch station to the proper angles and thickness to indicate the amount of stock to be removed at that station. The grooves are filed to templets and to a protractor such as seen in Fig. 1.

The propeller blade is now ready for the finishing operations. The first step consists of milling the edges to the desired contour. The excess stock near the hub end is next routed out by means of rotary files. Sanding rolls driven by pneumatic drills are used adjacent to the hub end to obtain a high degree of smoothness.

The remainder of the blade is ground down to the thicknesses and angles required at the various stations by means of flexible sanding disks driven by portable units of the type seen in Fig. 7, which were supplied by the Carborundum Co. Emery disks are used in roughing, semi-finishing, and final finishing. During this sanding, the blades are returned from time to time to the inspection benches to determine how closely they are being finished to the required angles and thicknesses.

When each propeller blade has been developed to its desired form and dimensions, it is taken to the equipment illustrated in Fig. 5, where a continuous sanding belt is moved lengthwise along the propeller blade to completely remove all crossed grinding marks resulting from the previous operations. An interesting mechanical feature of this operation is that the propeller blade is mounted on a unit completely separated from the sanding machine, and yet the operator need only press buttons on each side of the sanding head to cause the propeller blade holder to swivel and thus present the blade in any desired plane in relation to the sanding head. This sanding machine produces smooth blade surfaces without "valleys and peaks."

The last step in this department consists of polishing the blades on the Hammond machine illustrated in Fig. 6. When a blade leaves this machine, it has been finished to the nicety of a master blade.

Fig. 10. Propeller Hubs are Finished All Over. This Operation Shows how the Fillets at the Joints of the Blade Barrels are Milled

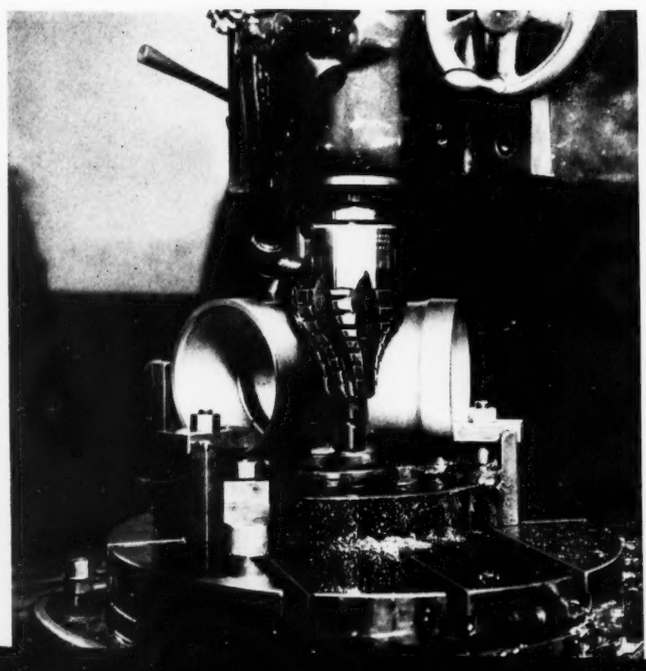
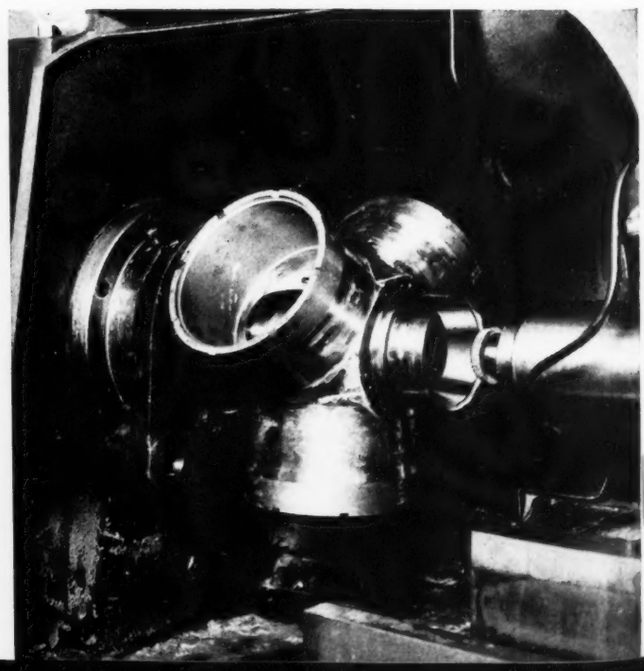


Fig. 11. Grinding a Tapered Seat in One End of the Propeller Hub to Receive an Anti-friction Bearing for the Propeller Shaft



"CIGARETTE PAPER" BALANCE

Static balancing is accomplished on the stand shown in Fig. 8, which is fitted with hardened and demagnetized steel bars on which the propeller blade and its master blade are placed for inspection. The area around this balancing stand is completely enclosed by a canvas tent which excludes all drafts or air currents. The stand is adjustable in every direction and is checked positively every morning.

The balancing stand is erected over a pit, so that blades for 16-foot propellers can be balanced with the inspector standing on the floor. Before a blade passes the balancing test, it must be possible to turn it into any position around a full circle and to have it remain in that position without any perceptible movement. Correction for unbalance is made by pouring molten lead into the hole that was drilled in the hub end of the propeller blade in the second machine operation. By balancing each blade to a master, they are interchangeable.

Typical operations on propeller hubs are illustrated in Figs. 9, 10, 11, and 12. They are received in the rough from the forge shop and are machined all over in order to obtain minimum weight and a highly polished finish that will facilitate the detection of possible flaws by the Magnaflux process. Fig. 10 shows the method of finishing the fillets where the blade barrels join each other. Use is made of a formed milling cutter on a Cincinnati vertical milling machine.

The tapered seats provided at the front and rear of the hub to receive anti-friction bearings for the propeller shaft are finish-ground on a Bryant internal grinding machine, set up as illustrated in Fig. 11. These seats are held to the maximum diameter within plus 0.000 inch minus 0.005 inch, and the taper must be correct within 10 minutes. In addition, the two cone seats must be concentric with the spline and show a bearing of at least 75 per cent.

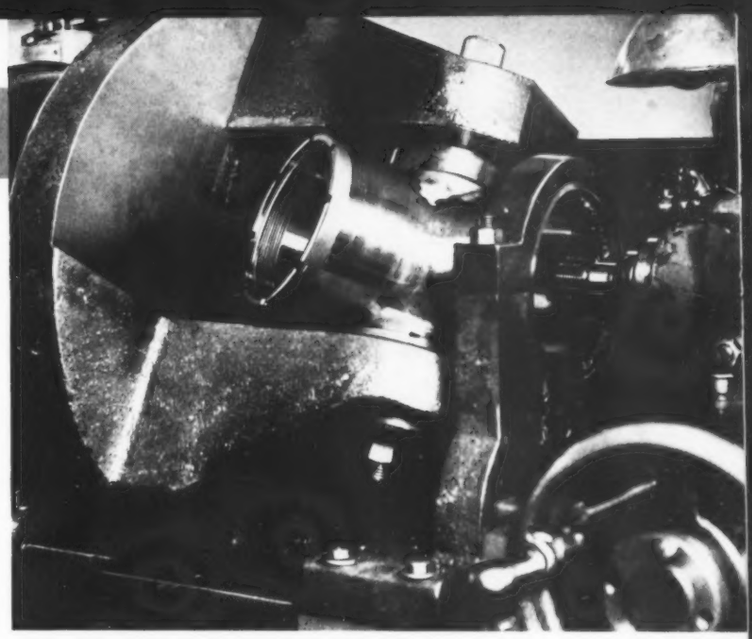


Fig. 12. Threads are Milled to a High Degree of Accuracy in Each of the Blade Barrels of the Propeller Hub

The three bearings in the propeller hubs are finish-ground in a Heald internal grinding machine, as illustrated in Fig. 9. These bores must be held to size within plus 0.0008 inch minus 0.0003 inch and be straight within 0.0005 inch. Threads are milled in the end of each hub barrel by means of the Lees-Bradner thread-milling machine shown in Fig. 12. These threads are modified buttress threads, 8 per inch, and the pitch diameter is held between 7.221 and 7.227 inches.

All parts for the hub unit must pass a rigid final inspection, and after the hub parts and the propeller blades have been assembled, the complete propeller must undergo a static balancing test. Corrections for unbalance in the complete propeller are made by putting small blocks of steel in recesses provided in the hub barrels.

Making Sperry Gyropilots

AUTOMATIC flying of planes after they have attained altitude is general practice today as the result of the development, by the Sperry Gyroscope Co., Inc., Brooklyn, N. Y., of an instrument known as the Gyropilot. When a plane is aloft, this instrument takes over the complete burden of the actual flying and makes it possible for the human pilots to devote their attention to observation, navigation, the sending and receiving of radio messages, and engine control.

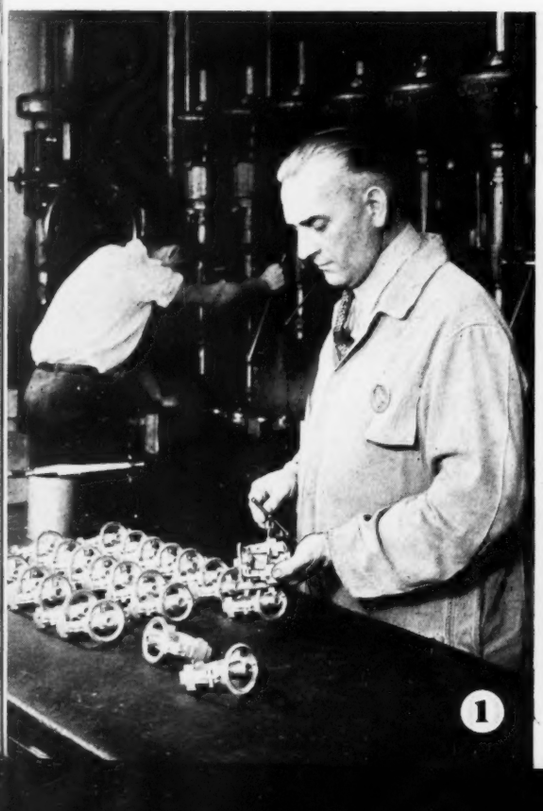
This instrument detects the slightest deviations of the plane from its set course and altitude, and immediately applies corrective movements to the controls. The Gyropilot has proved indispensable on transoceanic flying boats, which must be navigated with close accuracy during long flights, and is used extensively on other planes—commercial, military and private.

The Gyropilot is made up of the Gyro-Horizon and the Directional Gyro, which were first developed as separate "blind flying" instruments. The combined instrument controls flying laterally, longitudinally, and in the direction in which the plane is moving. Smooth and positive operation of the various controls and of the aircraft is insured by the Gyropilot being operated hydraulically and pneumatically.

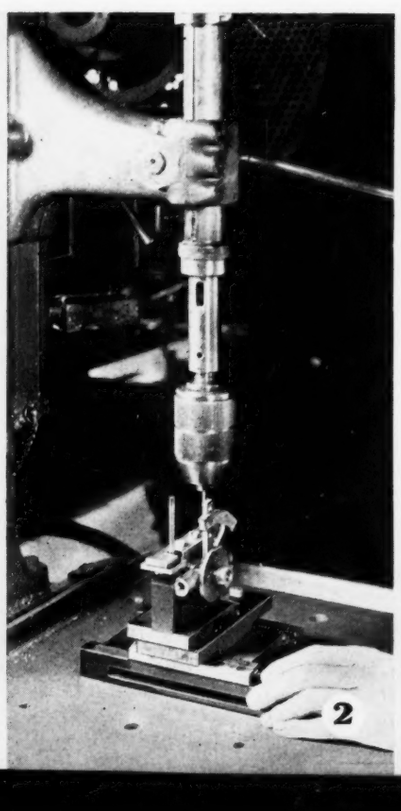
The manufacture of these aircraft instruments is characterized by a large number of operations in which extreme accuracy is demanded on small parts of delicate construction. For example, the vertical ring for the Directional Gyro consists of a rectangular-shaped frame with a large opening in the center and a wall of small cross-section, as seen in the man's hand in Fig. 1. Two small holes must be tapped through opposite sides of this frame in line within 0.0003 inch. The opening between the frame walls is 3 1/4 inches and the wall thickness is only 5/16 inch. These holes are threaded, as illustrated, by using a special Pratt & Whitney hand tap having a long pilot that is guided by the opposite hole in tapping either hole. The tap is 1/4 inch in diameter and has 32 threads per inch. The part is an aluminum die-casting.

The same part is being turned in Fig. 3 to an outside diameter of 4.600 inches within plus 0.0005 inch minus 0.0000 inch, this tolerance being customarily specified for turned surfaces. Caution must be observed in this operation to avoid springing the part through clamping it too tightly be-

Tapping Small Holes in Opposite Sides of a Slender Instrument Frame in Line within 0.0003 Inch



Milling Two Narrow Slots in a Part that Must be to Size and Parallel within Close Tolerances



Turned Surfaces are Generally Held to Size within a Total Tolerance of 0.0005 Inch, even on Interrupted Cuts

for Automatic Flying

tween the faceplate fixture and the ball-bearing tailstock center. The interrupted cut increases the machining problem.

The operation illustrated in Fig. 2 consists of milling two narrow slots in arms of an instrument part, to size and parallel within extremely close tolerances. The power or Servo unit for Gyropilots has a Dowmetal casting that is drilled, counterbored, and reamed while held in the jig seen in Fig. 4, this jig being designed for handling three lengths of this casting. A total of nine holes are machined in the part while it is held in this jig to center distances that must be maintained within 0.005 inch. Valve-guide holes approximately 1/2 inch in diameter extend the full length of the casting, as well as cylinder holes approximately 1 1/4 inches in diameter which are core drilled by this machine and later rough- and finish-broached.

All Sperry aviation instruments are fitted with tapered pivot points of carbon-chromium steel for supporting oscillating parts. These parts turn on balls that ride on the pivot points at a diameter that is approximately 1/8 inch. Each pivot must be concentric within 0.0001 inch as determined by revolving it on a stand in contact with a Federal indicator. These pivot points are lapped as illustrated in Fig. 5, after having first been ground.

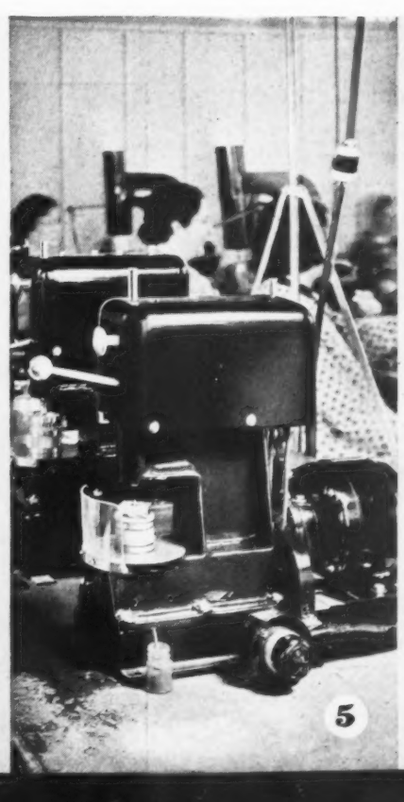
In the lapping operation, the pivot point revolves only once in every fifteen seconds. The lap runs from 1700 to 1800 revolutions per minute and reciprocates up and down into and out of contact with the pivot point. A special compound is applied to the work. Each pivot point is lapped four minutes with a wide-band brass lap and then four minutes with a narrow lap. The finish of these pivot points is highly important and among the precautions taken to avoid corrosion is the use of stainless-steel trays for handling them.

A small piece of sheet duralumin 0.100 inch thick attached to a bail ring for a Gyro-Horizon is being faced in Fig. 6. This surface must be very smooth and be parallel with other surfaces and square with the axis within 0.0002 inch. The operation requires utmost care because this part is particularly springy and the cut is an intermittent one. In addition, the edge of the duralumin sheet which bisects the center of the part is tapered to a thickness of 0.005 inch, and even 0.003 inch on some bail rings. This "knife edge" must be finished clean and smooth. The tool is tipped with tungsten carbide.

Servo Unit Housings are Completely Drilled, Counterbored and Reamed in the Jig Here Illustrated

Tapered Pivot Points for Sperry Aircraft Instruments are Lapped Concentrically within 0.0001 Inch

Facing Operation that Necessitates Great Care because of the Springiness of the Part and the Intermittent Cut



Grinding Threads Increases

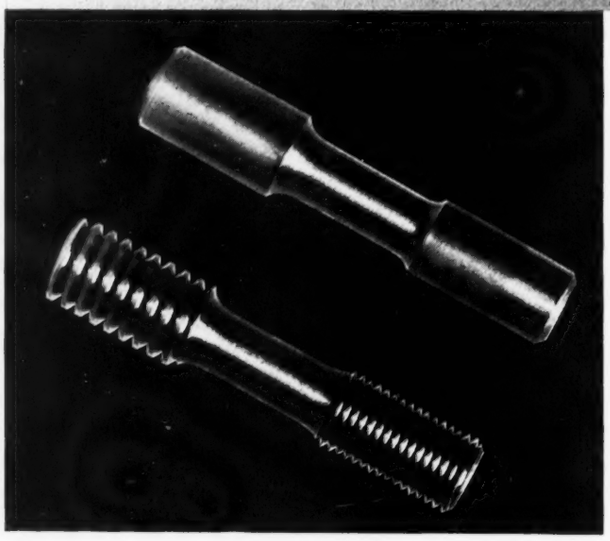


Fig. 1. Ground-thread Cylinder Hold-down Stud and the Hardened Blank from which it is Produced

IN the building of aircraft engines, which today weigh only slightly over one pound per horsepower, the same care must be exercised in producing the smallest stressed parts, such as studs and bolts, as in making the parts used in actual power development or transmission. With each cylinder developing at take-off two-thirds as much power as the total output of the most widely used nine-cylinder radial aircraft engine of ten years ago, the sixteen studs that hold a cylinder to the crankcase become as important in their function as the cylinder itself, and their manufacture must be as painstakingly accurate.

At the plant of the Wright Aeronautical Corporation, Paterson, N. J., it is the practice to grind the threads of all such stressed parts as cylinder hold-down studs, adjusting screws, rocker hub bolts, and crankshaft clamp screws in order to increase the thread accuracy, which, in turn, gives greater durability of these parts. The threads are ground from the solid after the parts have been hardened.

This method has practically eliminated the minute cracks formerly found at the bottom of threads on parts hardened after the threads were cut. Other important advantages are the elimination of distorted threads due to hardening and the securing of better fits with the internal threads of mating parts, which, in turn, are cut by taps on which the threads have been ground.

Studs that are under-cut between the two threaded ends, as shown in Fig. 1, are ground in two operations performed on Ex-Cell-O machines, set up as illustrated in Fig. 2. A driving dog is fastened on one end of the stud by the rough-grinding operator, and is passed with the stud to the finish-grinding machine, not being removed until after the completion of the finish-grinding. This practice insures that the work will be held identically for both roughing and finishing.

On shoulder work, roughing and finishing cuts are taken on the threads by the same machine. Rough-grinding is performed from the end of the part to the shoulder, and then the carriage is tripped for the return movement, during which the threads are finish-ground.

The rough-grinding operation leaves 0.007 inch of stock on all thread surfaces for removal in finish-grinding. Errors in lead, form, and taper per inch at the end of the finish-grinding must be held to within 0.001 inch. On under-cut work, such as the cylinder hold-down studs, the rough-grinding wheel is dressed after approximately every twenty pieces, and the finish-grinding wheel is dressed after about every forty pieces. On shoulder work, where rough-

Fig. 2. Ex-Cell-O Thread-grinding Machines are Employed for a Variety of Studs, Bolts, and Screws

Stud Durability

ing and finishing cuts are taken by the same grinding wheel, as already explained, the wheel is dressed after approximately every ten pieces. The average production in rough-grinding cylinder hold-down studs is 70 pieces an hour, and in finish-grinding, 100 pieces an hour.

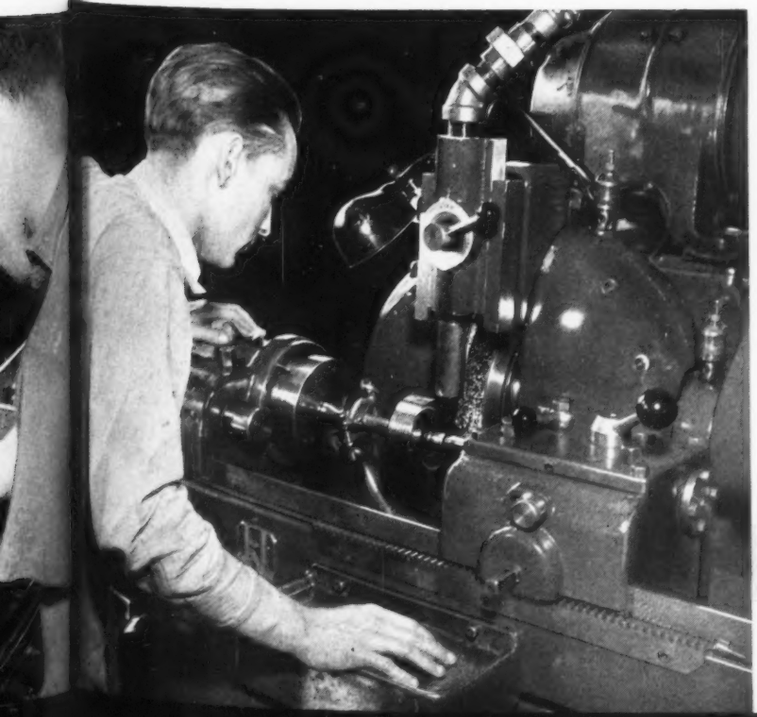
Threads as small as 5/16 inch outside diameter, 24 per inch, and as large as 1 1/2 inches outside diameter, 12 per inch, are being ground on regular production work. Larger threads are ground in special instances as, for example, in Fig. 4 is shown a thread gage 3 7/16 inches outside diameter, 12 threads per inch, being ground in a Jones & Lamson machine. In the thread-grinding machines employed in this plant, thread accuracy is insured by the use of lead-screws which are changed whenever the pitch of the thread being ground is changed. Provisions for taking up and adjusting backlash insure accuracy of the lead-screws for a prolonged period. The hardness of the parts on which threads are ground ranges from 32 to 36 Rockwell C scale.

Fixtures equipped with dial gages are provided at the machines for checking the thread diameters. Lead, tooth form, etc., are inspected on the Jones & Lamson optical comparator shown in Fig. 3, which throws an image of the thread magnified 62.5 times on a screen for comparison with an enlarged outline of the thread. It is the practice to inspect approximately 10 per cent of each batch of parts going through the department. In addition to showing up inaccuracies of thread form, this optical instrument also enables a close check on the lead and taper.

Fig. 3. Finished Threads are Magnified 62.5 Times by a Jones & Lamson Comparator to Check Form and Lead

The installation of thread-grinding equipment has greatly reduced the rejections of threaded parts. The cost of ground-thread parts, considering the corrections formerly necessary for overcoming heat-treating difficulties and rejections due to cracks, is no more than the cost of the same parts produced by the methods previously in use.

Fig. 4. Grinding the Thread on a Thread Plug Gage in a Jones & Lamson Machine to Close Limits



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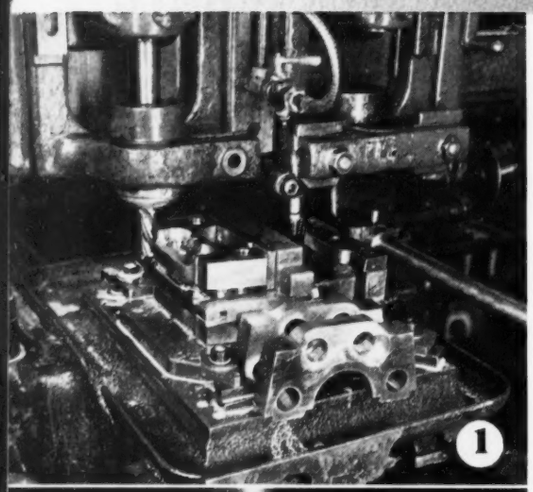
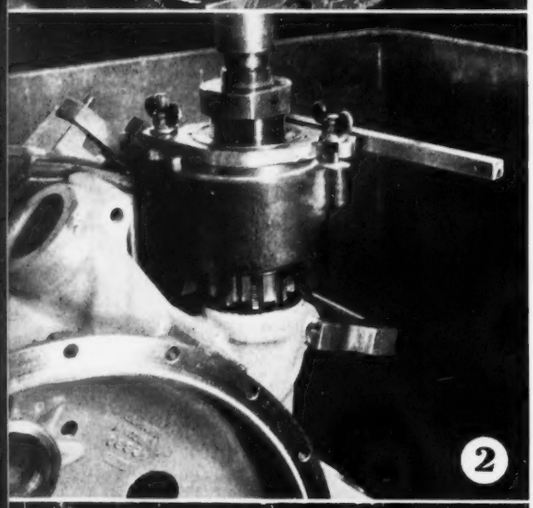


Fig. 1. Profile Milling the Ends of Caps for the Master Rods of Pratt & Whitney Aircraft Engines on a Machine Built by the Pratt & Whitney Division, Niles - Bement - Pond Co. Correct Contour is Obtained through a Tracer Pin and Former Plate. Fig. 2. Employing a Pratt & Whitney Shell Tap for Tapping an Airplane Blower Motor. Fig. 3. Using a Spiral-fluted Formed Cutter for Milling the Inside of a High-silicon Aluminum-alloy Piston



Figs. 4 and 8. Cincinnati Universal Grinding Machines being Used for Grinding the Hub (Fig. 4) and Bore (Fig. 8) of a Crankshaft in One Set-up of the Work. This Method was Made Possible through the Provision of a Hinged Internal Grinding Attachment which is Swung Downward into the Grinding Position for Finishing the Bore. The Headstock is Equipped with an Air-operated Pull-back Chuck. The Work is also Supported by a Center-rest and a Steadyrest

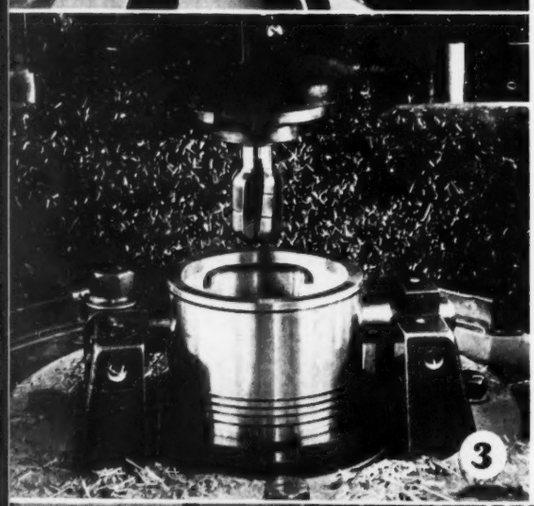
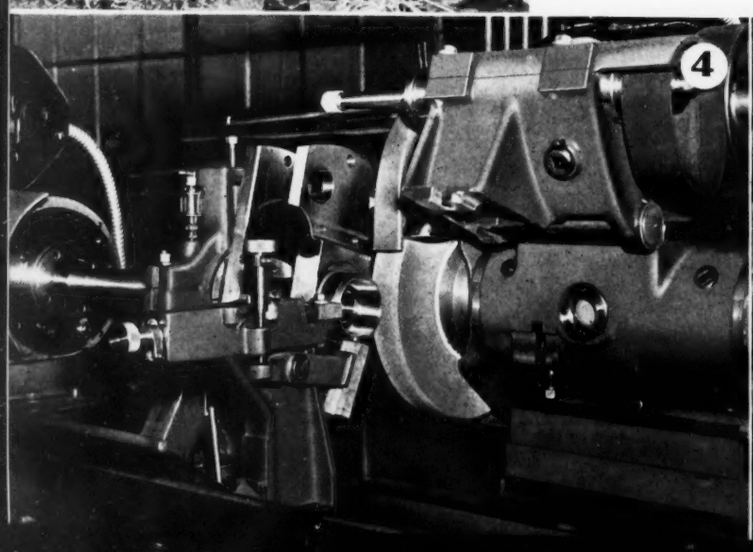
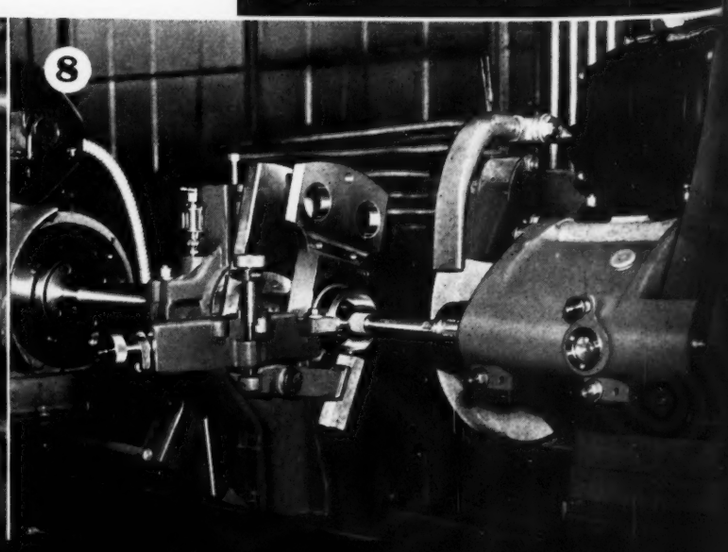


Fig. 5. Lapping the Teeth of the Stationary Reduction Gear for Wright Cyclone Engines in a Fellows Planetary Lapping Machine. These Gears are Nitralloy Steel Forgings on which the Teeth are Nitrided and the Web and Flange are Left Soft. The Teeth are Lapped to a Mirror Finish, with the Involute Tooth Profile Accurate within 0.0003 Inch. Fig. 6. Lapping Internal Teeth on the Inlet and Exhaust Cam for Wright Engines. At the End of This Operation there Must be from 0.006 to 0.010 Inch of Backlash between the Teeth of This Part and Those of a Master Gear. Fig. 7. Pump Drive Gears with Two Sets of Teeth are also Lapped at the Wright Aeronautical Corporation on Fellows Machines





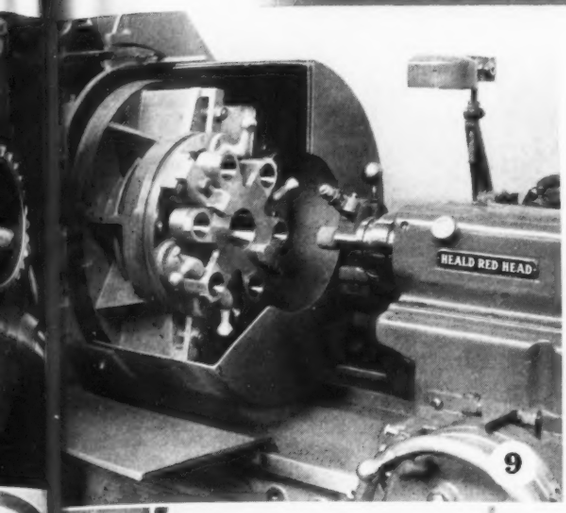


Fig. 9. Heald Internal Grinding Machine Finishing Six Bearings in Propeller Reduction-gear Cages. Each Bearing is Ground to 1.7716 Inches within Plus 0.001 Inch Minus 0.000 Inch, and the Chordal Spacing is Held within 0.001 Inch. Fig. 10. Reduction Pinions are Ground on the Hub by a Hollow Wheel which Grinds from the Inside

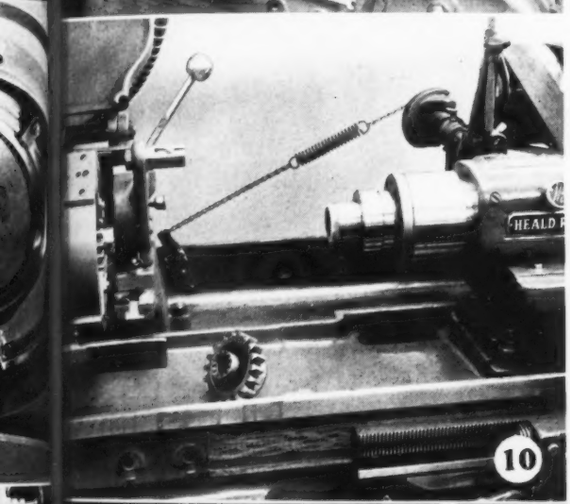


Fig. 11. Riveting a Wing Spar at the Consolidated Aircraft Corporation, San Diego, Calif., with a Hydraulic Machine Built by the Lake Erie Engineering Co. Over 275,000 Duralumin Rivets are Driven on a Consolidated Plane

Fig. 12. Grinding and Lapping from 900 to 1000 Piston-pins an Hour on Cincinnati Centerless Machines. They are Ground to Size within 0.0005 Inch by the Machine at the Left; Passed Automatically to the Middle Machine, which Removes from 0.0004 to 0.0007 Inch on the Diameter; and Finally Passed to the Third Machine, which Removes Only from 0.00005 to 0.0001 Inch on the Diameter

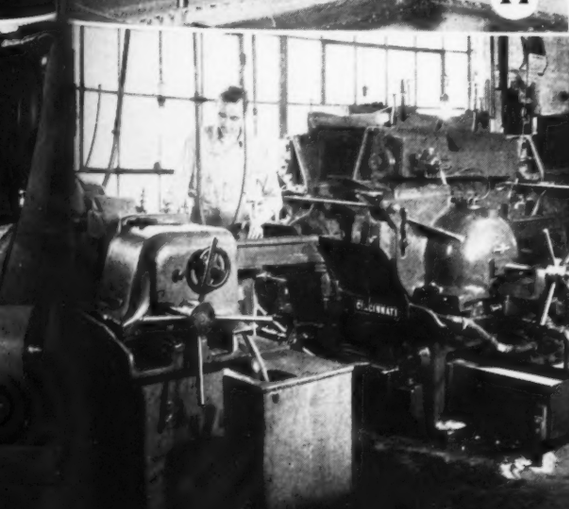


Fig. 13. Machining the Hub End of an Aluminum Propeller Blade in a 20-inch Fay Automatic. Tools on the Carriage and Back Arm Rough- and Finish-turn, Face, and Chamfer. Fig. 14. Turning and Facing the External Surfaces of a Cylinder Barrel in a Fay Automatic Lathe

Fig. 15. Finish-grinding the Bore of Cylinder Barrels at the Wright Aeronautical Corporation in a Bryant Chucking Grinder. Fig. 16. Bryant Chucking Grinder being Used in a Similar Manner on Pratt & Whitney Cylinder Barrels

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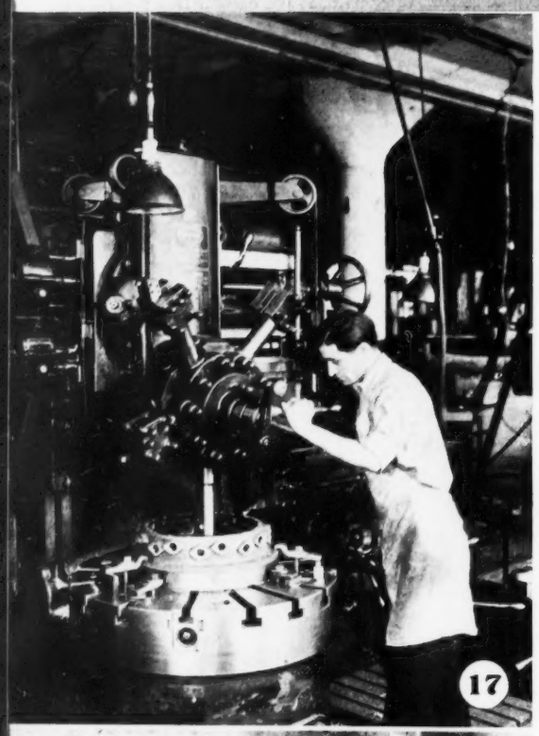


Fig. 17. Boring, Facing, and Semi-finish-turning Operations on the Intermediate Section of a Crankcase at the Wright Aeronautical Corporation. The Turned Outside Diameter Must be 15.260 Inches within Plus or Minus 0.0015 Inch. This Operation is being Performed on a Bullard Vertical Turret Lathe. Fig. 18. Bullard Mult-Au-Matic Used in a Foreign Airplane Plant for Machining Cylinder Heads. Fig. 19. Bullard Mult-Au-Matics Machining Chromium-molybdenum Steel Cylinder Barrels at the Wright Aeronautical Corporation. The Operation Consists of Semi-finish-boring, Turning the Flange, and Facing Both the Flange and the End of the Barrel

Fig. 20. Hardinge Precision Bench Lathe Machining a Part for the Link Aviation Trainer, a Mechanical Device Used on the Ground for Training Pilots to Fly by Instruments and Use Various Aids to Air Navigation. Fig. 21. Broaching Slots in Propeller Hubs by Means of a Lapointe Vertical Broaching Machine. The Hydraulic Fixture is Tilted Forward, as Shown, for Loading. A Slot is Broached Diametrically Opposite to Each Arm

Fig. 22. Four Barnes Honing Machines at the Wright Aeronautical Corporation Performing the Final Operation on Nitralloy Steel Cylinder Barrels. The Finish of These Bores is Held to Three Micro-inches (Three-millionths of an Inch of Roughness) as Checked with a Profilometer. The Bores Must also be to the Specified Diameter within Plus or Minus 0.0005 Inch and Must not Taper More Than 0.001 Inch or be Out-of-round More Than the Same Amount

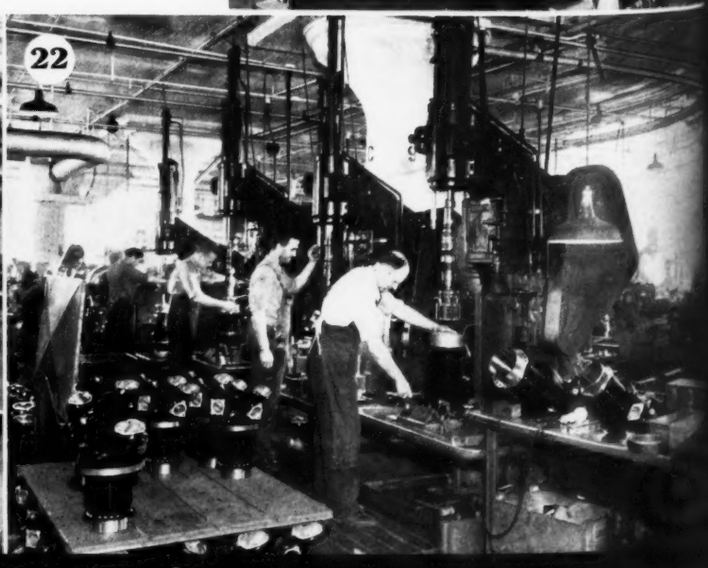


Fig. 23. Presses are Used for the Blanking and Forming of Innumerable Sheet-metal Parts for Use in Aircraft Fabrication. Here is a Niagara No. 5 Inclinable Press in Use at the Consolidated Aircraft Corporation, San Diego, Calif.

Fig. 24. An 800-ton Hyspeed Hydraulic Press Built by the Baldwin-Southwark Corporation being Used for Forming an Airplane Part at the Glenn L. Martin Co., Baltimore, Md.

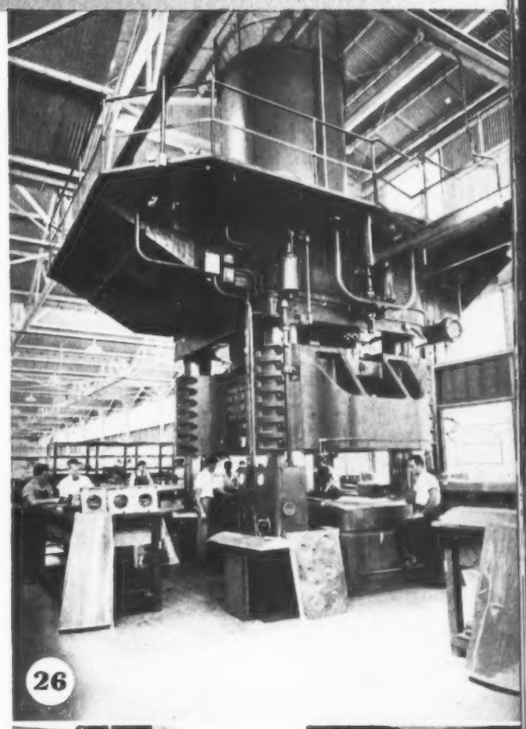


Fig. 25. Electric Spot-welding Operation on Aluminum Alloys at the Plant of the Chance Vought Aircraft Division of the United Aircraft Corporation, East Hartford, Conn. A Federal Spot-welding Machine is being Used

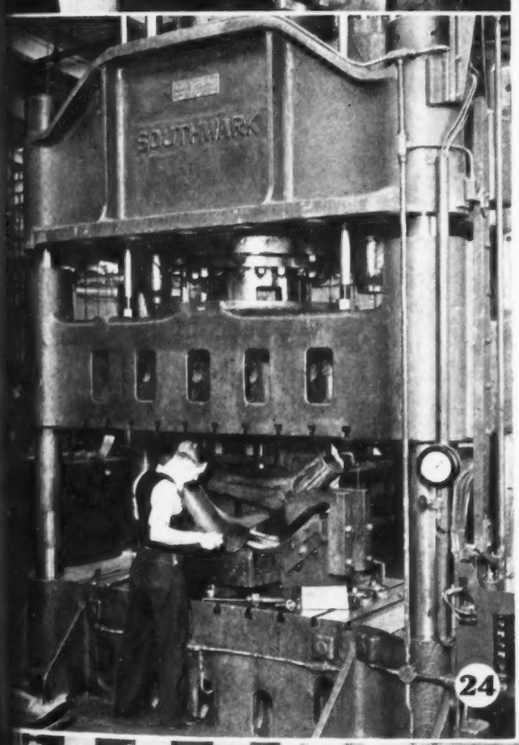


Fig. 26. Three Thousand or More Different Sheet-metal Parts are Blanked and Shaped at the Douglas Aircraft Co., Inc., Santa Monica, Calif., on the World's Largest Self-contained Hydraulic Press, which was Built by the Hydraulic Press Mfg. Co. This Press has a Capacity of 5000 Tons and Weighs 840,000 Pounds. Several Different Parts are Formed with Each Operation

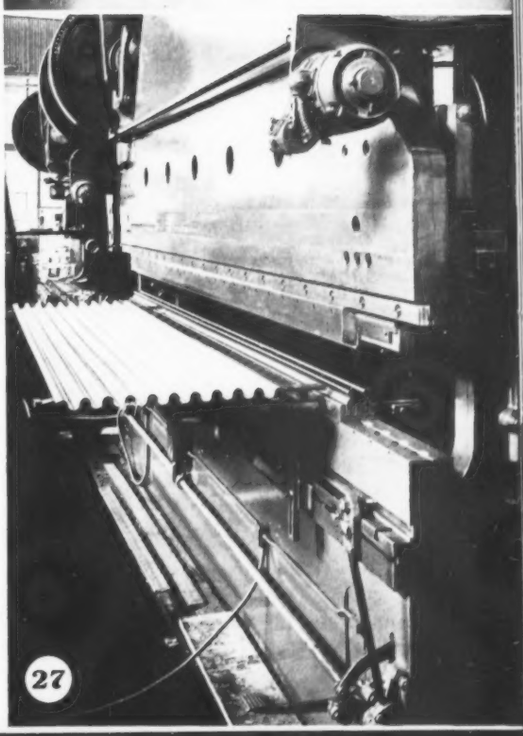
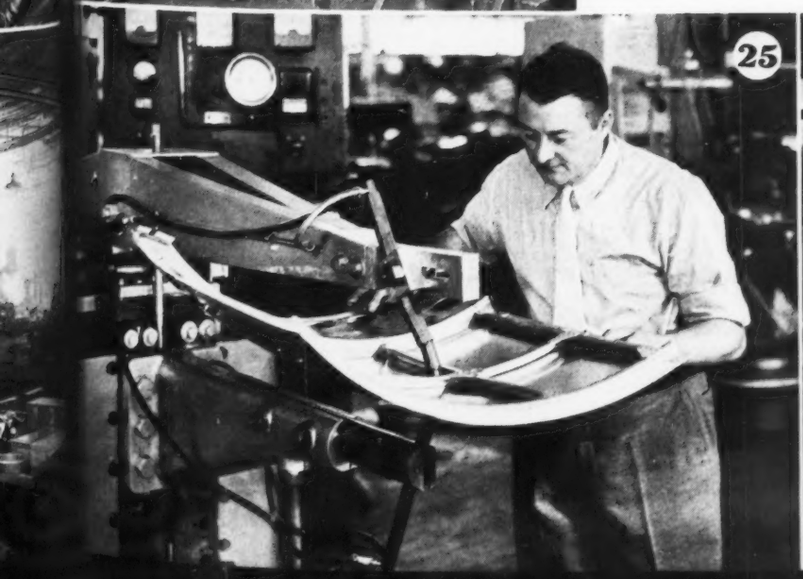


Fig. 27. Shears and Press Brakes also Play an Important Role in the Preparation of Sheet-metal Parts for Douglas Airplanes. The Press Brake Here Illustrated, Built by the Cincinnati Shaper Co., has Just Completed Corrugating a 16-foot Sheet. The Dies are Adjustable for Different Pitches of Corrugation.

Fig. 28. Douglas Transport Plane in the Assembly Stage, This Illustration Showing the Manner in which Corrugated Sheets are Used for the Rigid Construction of Wings



Airplane Wheels from the Lightest

By CHARLES E. DIEBOLD, Manager of Contract Manufacture
National Acme Co., Cleveland, Ohio

OUT of wells in central Michigan is pumped a brine that provides the silvery-white metallic element known as magnesium, which, in recent years, has been alloyed with other elements to obtain a metal that has only two-thirds the weight of aluminum and at the same time possesses comparable physical characteristics. An alloy having these properties is particularly advantageous to the airplane-building industry, in which minimum weight is of paramount importance. Magnesium alloys are, therefore, being used by that industry for a number of parts, such as crankcases, gear housings, instrument cases, starter parts, and wheel hubs.

The wheels and brakes for the low- and intermediate-pressure rubber-tired airplane wheels sold by the Goodyear Rubber Co. are machined by the Contract Manufacturing Division of the National Acme Co., Cleveland, Ohio, in a department that was equipped especially for this work. The wheels are magnesium castings ranging from 3 to 19 inches in diameter on the surface that the rubber tire fits. The over-all diameters range up to 23 inches and the lengths up to 18 inches. These wheels are machined from a sand-casting that contains approximately 89 per cent magnesium and small amounts of aluminum, manganese, and zinc.

The machining of magnesium presents a peculiar problem due to the fact that magnesium chips are inflammable. Precautions are, therefore, necessary in performing operations on magnesium in order to avoid sudden combustion of chips and damage to machines. The excellent machining characteristics enable fast cutting speeds.

Airplane castings must be as perfect as possible, and a great deal of cooperation between the machine shop and the magnesium foundries from which the castings are obtained was necessary before castings of the present high quality could be produced. For example, the castings must not only be sound throughout all sections, but some of them have small traction grooves around one end, the widths of which, as cast, are held within plus 0.010 inch minus 0.000 inch and the depths within plus 0.000 inch minus 0.005 inch. With such close casting limits being maintained, it is unnecessary to machine the traction grooves.

Extensive chemical analyses, X-ray investigations, and physical tests, plus the flexibility of the machine shop equipment to meet machining changes suggested by the foundry, led to the development of high-quality magnesium castings for airplane wheels. In the casting process, approximately twice as much metal goes into the feeders and risers as into the casting itself. For instance, on a wheel casting weighing 48 pounds, the feeders and risers weigh approximately 96 pounds.

These wheels are machined on both external and internal surfaces in operations performed on turret lathes, one of which is illustrated in Fig. 1. The first of these turret lathe operations consists of rough-turning the long hub surface with the work chucked from the inside. The work is then mounted in the turret lathe with the rough-turned hub held in long jaws that have been attached to the faceplate, these jaws eliminating overhang of the work. The brake drive-ring end of the casting is next roughed and finished.

The wheel is then again held in the turret lathe by adapters for the operation illustrated in Fig. 1. This consists of semi-finish- and finish-turning the hub, facing one end, and boring the same end. A combination of twenty-one tools, eighteen on the turret and three on the front cross-slide, are used for the complete machining of a typical wheel casting.

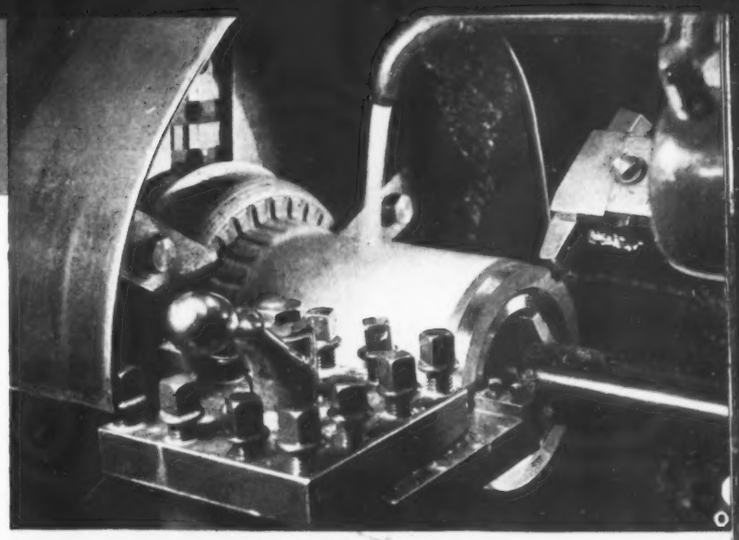
The cutting speed in the turret lathe roughing operations is approximately 610 feet a minute and the average depth of cut is 3/32 inch; in semi-finish-turning, the cutting speed is 460 feet a minute and the depth of cut is 1/16 inch; in finish-turning, the speed is 620 feet a minute and the depth of cut, 0.005 inch. The various turned diameters are held to size within a total tolerance of 0.001 inch, and each wheel has a bore for an anti-friction bearing that is held to size within plus 0.0005 inch minus 0.0000 inch.

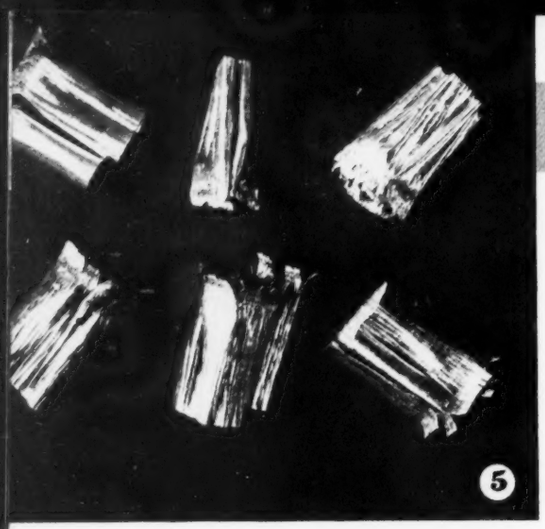
It is in the turret lathe operations that the utmost care must be taken to avoid combustion of the rapidly produced chips. This hazard has been greatly reduced, after a thorough study of the unusual conditions involved, by impressing upon the workmen the necessity of observing certain precautions. All rubbing or friction of chips must be avoided, and it is, therefore, essential that all tools be kept in a honed condition. The chips should be sheared, not rubbed off. They should be of the ribbon type shown in Fig. 5, not thick and crumbly.

As a general rule, broad-nosed tools, such as seen in Fig. 1, should be used for turning and facing cuts. A clearance of approximately 8 degrees is used for lathe tools and a rake of 15 degrees. Attention is also directed to the round cutting edge of the turning tool in Fig. 1. All tools should be hard enough to avoid rapid wear, but they need not be of extreme hardness and no lands should be provided on the majority of cutting tools. In using a narrow grooving or parting tool, care must be particularly observed to avoid the fine chips from adhering to the heated tool or from being rubbed between the tool and the walls of the groove.

Another important point to observe is to prevent chips from falling on ways or other surfaces where they would be subject to friction and catch afire. The hexagonal turret is, therefore, covered with sheet metal and covers are provided for the bed. The operator constantly rakes the chips from beneath the work and tools to one end of the lathe pan, and an attendant is kept busy removing the chips from the pans and sweeping the floor.

Water or liquid fire extinguishers should never be thrown on a pile of ignited magnesium chips, because they merely increase the blaze. Sand or fine cast-iron chips should be used instead, as they will effectively smother a fire. For this reason, pails of sand are kept adjacent to each of the machines working on magnesium. The contents of these pails are heated weekly in a furnace to remove any moisture that collects in them.





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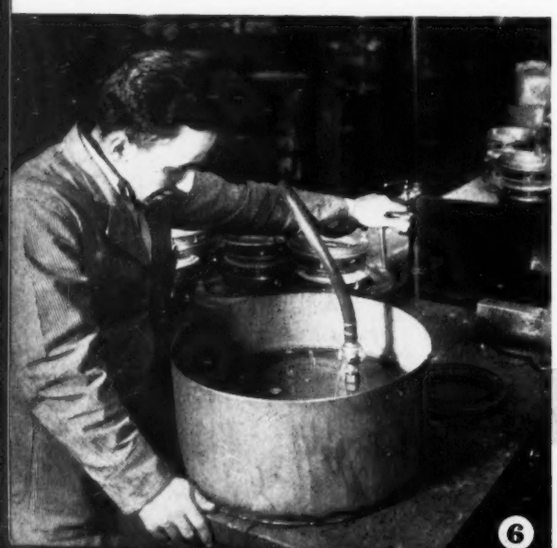
One of the important operations on the wheels, after the preliminary turret lathe operations, is to assemble studs around the face of the smaller end. Holes for these studs are being drilled in the machines seen in Fig. 2. For this operation, twist drills having a spiral angle of 35 degrees, smoothly polished flutes, and deep clearance were found most efficient. The cutting edges of these drills are made with a reduced land of approximately 0.015 inch and are chromium-plated to a thickness of about 0.002 inch to provide the sharp smooth edge that is necessary for the successful machining of magnesium. The stud holes are also tapped and counterbored on the same machines. Drilling and tapping operations must be analyzed thoroughly before tool standardization, because different sizes of holes present different problems and tools can be designed to meet them.

After the drilling and tapping operations, the wheels are dipped in agitated hot water having a temperature of 180 to 200 degrees F. They are then plunged directly into a chromium pickle to distribute a film over all surfaces, thus guarding against corrosion after the wheel is placed in service. This bath also prepares the various surfaces for painting by slightly etching them.

A bitumastic black paint is then applied to the bore that has been finished for the anti-friction bearing, after which the bearing race is pressed into place. This race can be assembled readily because of the hub casting being expanded.



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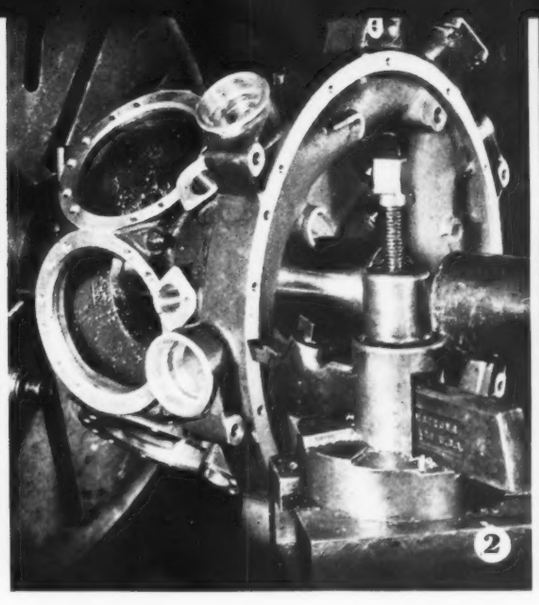
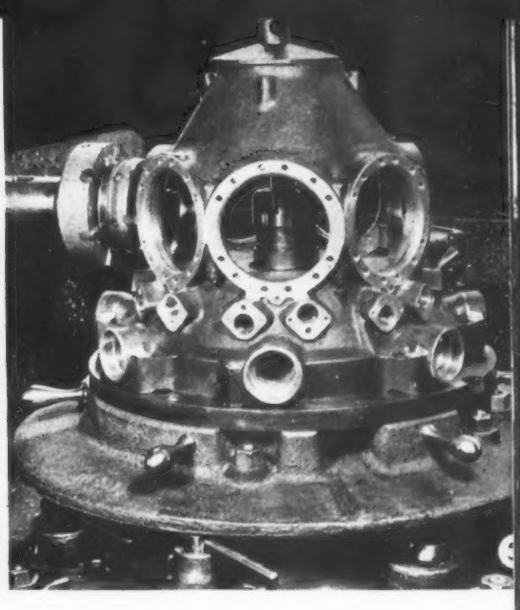
The wheels are then returned to the turret lathe for accurately turning a bevel register on the hub end that contains the holes for the studs. Machining of the beveled surface is performed at this time, rather than when the other cuts are taken on the hub, in order to avoid possible changes of this beveled surface by the chromium pickle and bearing assembly. Studs that have been contracted in dry ice are next assembled into the tapped holes, care being taken to avoid the possibility of bulging the metal outward around the assembled studs. When these studs expand as they reach the temperature of the casting, they are, of course, held securely in place. Bitumastic black solution is sprayed into the tapped holes before the studs are assembled. This gives a good coating over the thread surfaces.

The various wheel and brake parts are painted, after machining and chromium-pickling, with a zinc chromate primer which is thinned to suit the requirements of a spray gun. The yellowish-green paint adheres readily to all surfaces and provides an exceptionally good base for aluminum lacquer. The aluminum lacquer is also sprayed on in the booth that is seen in the background in Fig. 4. Before any painting is performed, however, all parts are washed in either gasoline or an alkaline cleaner.

Every wheel and brake assembly must be statically balanced within a tolerance that varies somewhat with the size of the unit. On the particular wheel illustrated in Fig. 3, for instance, the unbalance must be held to within 25 ounce-inches. For the balancing inspection, the wheel assembly is mounted on ball bearings on an arbor. Lead strips are placed around the periphery of the inner and outer flanges of the wheel to effect balance within the specifications. Molten lead is then sprayed with a gun, as shown in Fig. 3, to the inside cored section of the wheel wherever additional weight is required. Flanges that are fitted to the smaller end of the wheels are balanced with the hubs, and corresponding serial numbers are stamped on the hubs and flanges to insure correct assembly.

Roving inspectors keep a close check on the production of all parts, and there is a final rigid inspection not only for all dimensions and balance, but also for leakage of the brake assemblies. In this leakage inspection, the entire assembly is immersed into a tank of commercial alcohol, as shown in Fig. 6, and then an air pressure of 100 pounds per square inch is admitted into the inside of the unit through a suitable connection for a period of thirty seconds. If the unit is not absolutely tight, leakage will be immediately apparent by the rising of bubbles to the surface of the alcohol.





Carboloy Tools on Continental Engines

Fig. 1. The Combustion Chamber Dome in the Cylinder Head of the Radial Type Aviation Engines Manufactured by the Continental Motors Corporation, Detroit, Mich., is Rough- and Finish-machined by Carboloy Tools to Obtain a High Degree of Smoothness that will Prevent the Accumulation of Carbon on This Surface. The Tool is Mounted on a Pivoted Holder. From 75 to 80 Cylinder Heads are Machined per Grind of the Roughing Tool and 200 Heads per Sharpening of the Finishing Tool

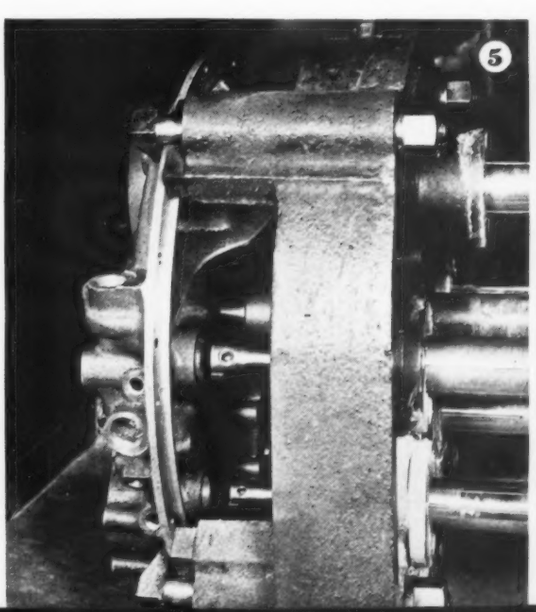
Fig. 2. Facing, Boring, and Chamfering the Accessory-case Contact Surface of a Continental Crankcase. The Bore Diameter Must be Held to 16.500 Inches within Plus or Minus 0.001 Inch. The Carboloy Tools Finish from 40 to 50 Castings per Grind, whereas the Tools Previously Used had to be Reground after Machining an Average of Five Castings. The Crankcase is of a Special Airplane Aluminum Alloy. It is Run at 125 Revolutions per Minute. The Feed is 0.010 Inch, and the Depth of Cut is 1/64 Inch. No Coolant is Used

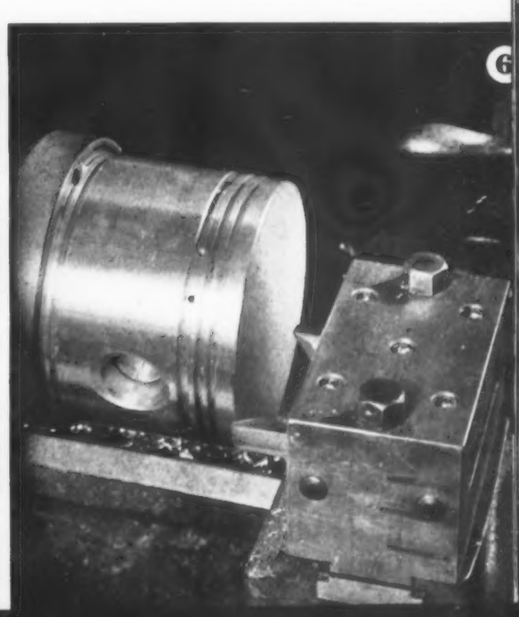
Fig. 3. Finish-facing and Chamfering the Seven Faces of the Crankcase to which the Cylinder Barrels are Bolted. The Distance from These Seats to the Center Line of the Crankcase Must be Held within Plus or Minus 0.002 Inch, and the Seats Must be Exceptionally Smooth and Flat so as to Insure an Oil-tight, Metal-to-metal Fit. The Cutter Runs at 125 Revolutions per Minute and is Fed by Hand, the Depth of Cut Being 1/64 Inch. Eight Hundred Faces have been Finished per Grind of the Tools. Soluble Oil is Used

Fig. 4. Rough- and Finish-turning a Valve Tappet Guide and, in the Same Operation, Facing the Inside of the Flange. As in Many Other Operations in Aircraft Engine Plants, the Service Required of the Tools is Particularly Heavy because of the Toughness and Density of the Aluminum Forging and the Intermittent Facing Cut. The Work Runs at 500 Revolutions per Minute, the Feed is 0.010 Inch, and the Depth of Cut is 1/64 Inch. Limits of Plus or Minus 0.0002 Inch are Specified. The Daily Production is 240 Pieces

Fig. 5. Finish-boring Seven Gear Shaft Bearings from 1 to 1 5/16 Inches Diameter in an Aluminum Casting. In This Operation, the Hole Diameters are Held to Size within Limits of Only Plus or Minus 0.0005 Inch. The Tools Run at 300 Revolutions per Minute, the Feed is 0.010 Inch, and the Depth of Cut is 1/64 Inch. Cutting Oil is Used. The Carboloy Tools are Set up Only Twice a Year on This Job, whereas the High-speed Steel Tools Previously Used had to be Set up at Least Once Every Week

Fig. 6. Finish-facing and Beveling the Head of a Forged Aluminum Piston 5 1/8 Inches in Diameter. The Over-all Length Must be Held to Size within Plus or Minus 0.005 Inch. The Operation is Performed at a Speed of 500 Revolutions per Minute. Two Hundred Pistons are Finished per Grind of the Tool. Carboloy Tools are Also Used in Cutting Four Grooves in the Pistons which Must be Held to Width Limits of Plus or Minus 0.0005 Inch and for Semi-finishing the Piston-pin Holes within Plus or Minus 0.00015 Inch





Oxy-Acetylene Welding in

By A. K. SEEMANN
The Linde Air Products Co., New York City

OXY-ACETYLENE welding has proved itself a production method particularly well suited to the problems of airplane construction, because it enables the permanent union of two or more metal parts with minimum weight and with the required strength. The flexibility of this method of fabrication facilitates the meeting of production schedules and the construction of planes according to the varied specifications of their designers. Utmost freedom of design is possible with oxy-acetylene welding, and there are many instances of welded joints consisting of a multiple number of tubes that extend in as many directions to other tubes comprising the airplane structure.

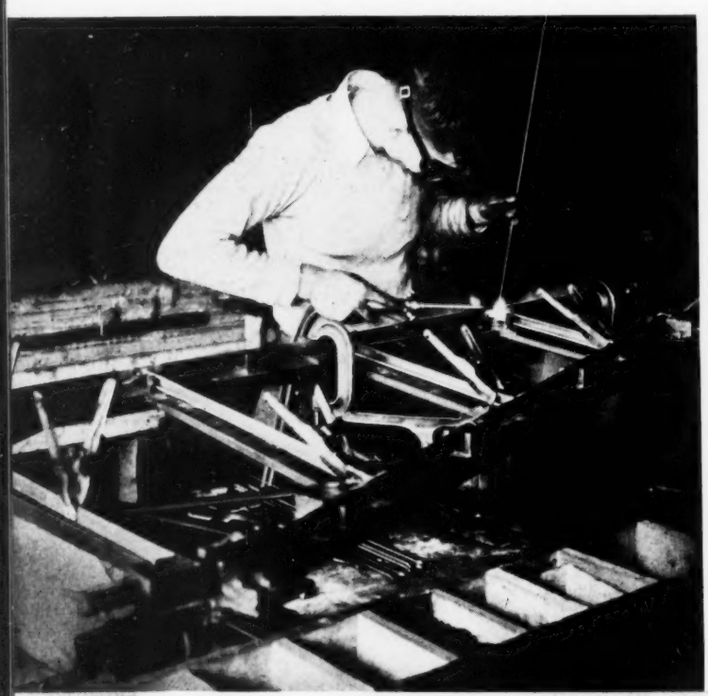
Welded tubular construction is used almost exclusively for the fabrication of the fuselage, wings, ailerons, stabilizers, rudders, etc., of small and medium-sized airplanes. On the larger planes of all-metal stressed-skin construction and on smaller planes of monocoque fuselage construction, welding is largely confined to such units as engine mounts, landing-gear assemblies, gun mounts, tail-wheel assemblies, and spar joints.

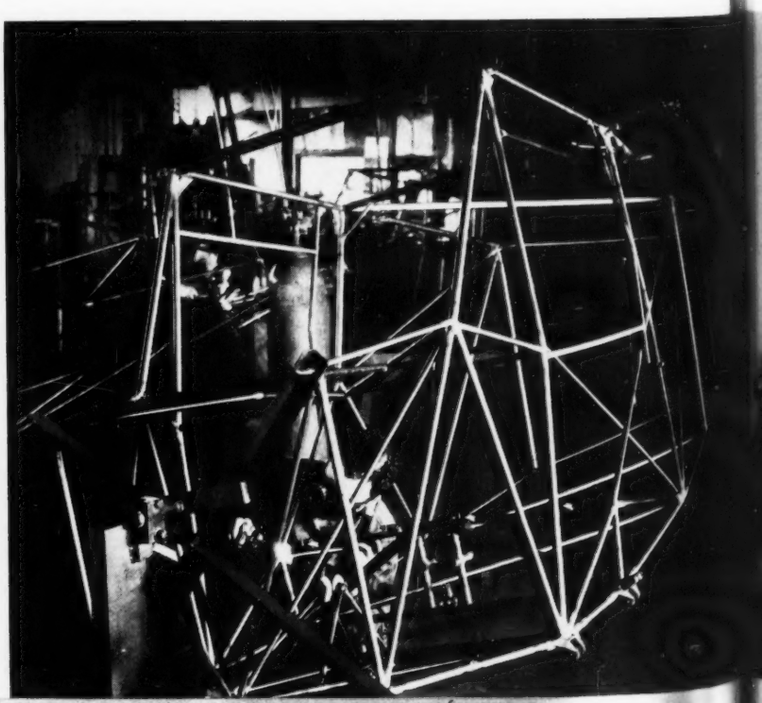
Seamless tubing of S A E 1025 carbon steel or X4130 chromium-molybdenum steel is used almost exclusively in airplane construction, approximately 90 per cent of the total volume of tubing being of the last-named specification. Tubing ranging from 1/2-inch diameter with a wall only 0.035 inch thick up to 3 inches in diameter with a 1/4-inch wall is in general use.

On one popular-priced sport plane there is approximately 600 feet of tubing and 850 separate oxy-acetylene welds. The large number of welds and the amount of tubing required in fabricating the fuselage of such a plane will be obvious from Fig. 2, which shows the fuselage for one of the

Fig. 1. Oxy-acetylene Welding Enables Airplane Structures of the Required Strength to be Built up Conveniently to a Variety of Designs

Fig. 2. Approximately 600 Feet of Tubing and 850 Oxy-acetylene Welds are Necessary in Fabricating the Taylorcraft Monoplane





Taylorcraft two-passenger, high-wing monoplanes built by the Taylor-Young Airplane Co., Alliance, Ohio.

Jigs are used extensively in airplane welding to speed up production and insure both interchangeability and alignment accuracy. This last point is of extreme importance in airplane building because all parts must fit precisely without setting up undesirable stresses in the finished plane. Fig. 1 shows a jig with tubes and other structural members held in place by clamps while being welded into a stabilizer for a Taylorcraft plane. In Fig. 3 is shown a much larger jig of a turn-over design which is used in welding a fuselage side truss in the shop of the Chance Vought Aircraft Division of the United Aircraft Corporation, East Hartford, Conn.

Tubing and strip for sections to be welded are first cut to the required lengths and slotted to receive gusset plates or cut to the angles necessary for closely fitting other tubes, before being delivered to the welders. Other parts are formed, stamped, drilled, etc., to meet a variety of assembly requirements.

Careful inspection of welding operations is observed in all plants, it being the practice to keep a check on the quality of each welder's work by frequently selecting completed welds at random and giving them a thorough test. This practice leads to continual effort on the part of the welders to keep their work up to the standards that have been established for them.

Welding is performed extensively in the aircraft industry on other materials besides seamless steel tubing. For example, in Fig. 4 an oxy-acetylene welding operation is being performed on an aluminum oil tank in the plant of the Boeing Aircraft Co., Seattle, Wash. Such units as collector rings, exhaust stacks, and boilers for cabin-heating systems are welded from stainless steel. In fact, there are shops devoted exclusively to the fabrication of parts from stainless steel for aircraft applications.

Fig. 3. Turn-over Jig which Insures Accuracy of Alignment, Interchangeability, and Elimination of Stresses in Welding on Airplane Structures

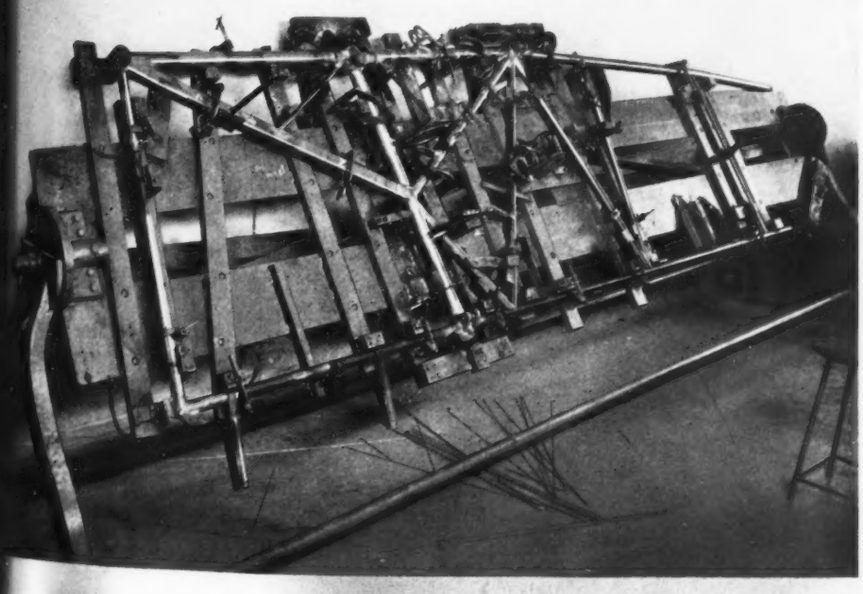


Fig. 4. Applying the Oxy-acetylene Torch for Welding an Aluminum Oil Tank in the Plant of the Boeing Aircraft Co. for a Transoceanic Plane

Shops that Keep the Planes Aloft

By WILLIAM HOARE, Superintendent
Cheyenne Repair Depot of the United Air Lines

THE operation of fleets of airplanes by the large air-lines necessitates servicing facilities at various airports and also extensive maintenance shops where the airplanes can be periodically inspected and overhauled. Every airplane flown by the United Air Lines is sent to its maintenance shop at Cheyenne, Wyo., after each 400 or 600 hours of flying, the intervals between inspections depending upon the type of plane. This shop normally employs about 375 men for the reconditioning of the planes.

When an airplane reaches the maintenance shop, the propellers, engines, instrument panels, wings, rudder, etc., are all dismantled until little is left but the hull. Newly overhauled engines are waiting for immediate installation, and this is also true of instruments, radio sets, and electrical equipment. Reassembling operations are seen in progress in Fig. 1. With this system, planes are held up but a minimum length of time in the maintenance shop. Other units or parts of the plane, such as the wings, landing gear, tail surfaces, and cabin equipment, are given immediate careful inspection, and after repairs are made, they are reassembled to the plane. There are approximately sixty employes in the dismantling and reassembling department.

All engines are sent to a shop department that has a capacity for handling approximately twelve a week. Here the engines are completely disassembled and all steel parts of both the engine and the propeller unit are carefully checked for invisible flaws by means of the Magnaflux method after they have been magnetized in the machine shown in Fig. 3, and then immersed in Magnaflux solution. This illustration shows a propeller shaft in the magnetizing machine and a crankshaft on the inspection table.

The machine shop (Fig. 4) is equipped with a considerable variety of machine tools for the production of a miscellaneous variety of parts required on airplanes. It is equipped with milling machines, shapers, turret lathes, tool-room lathes, several sizes of internal grinding machines, universal grinders, and surface grinders for the production of parts that must generally meet close dimensional tolerances. Important parts, such as cylinder barrels, articulated rods, propeller shafts, and propeller hubs, are purchased from the builders of the engines and maintained in the store-room in sufficient quantities to meet requirements. The machine shop equipment also includes a General Electric furnace for heat-treating the various alloy steel parts. This shop employs twenty-six men.

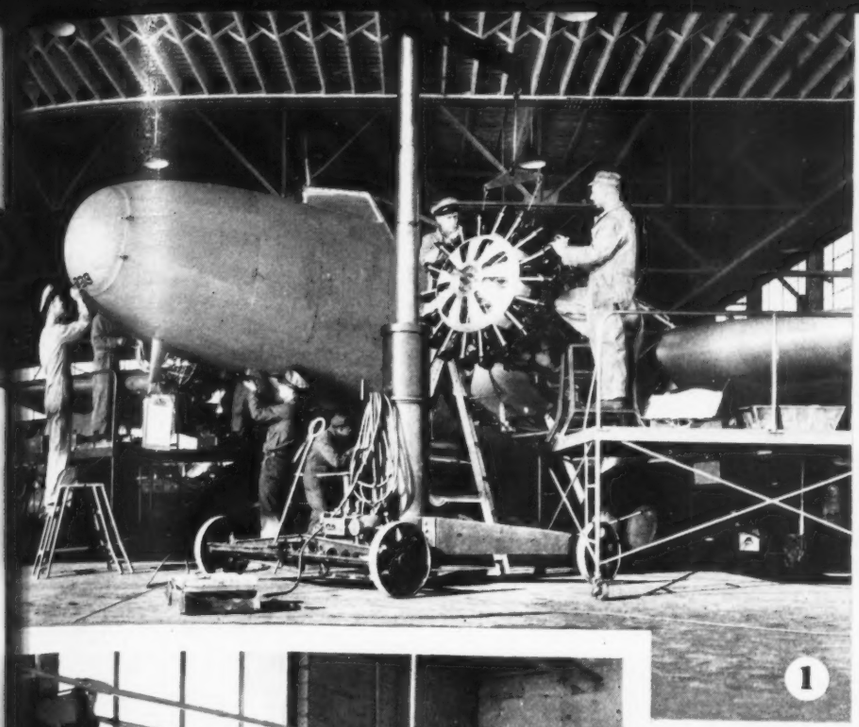
Repaired and checked engine parts are reassembled in the engine overhauling shop, which employs forty-five men. Here all engines are subjected to a test-block running of from six to twelve hours prior to their installation on planes. When a plane has been completely reassembled and checked, a pilot performs thorough tests in the air.

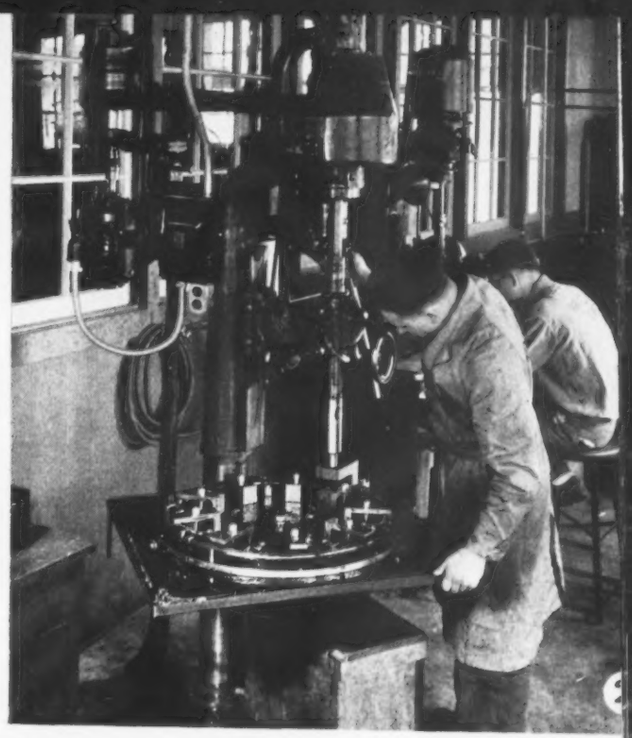
All instruments, from automatic pilots to small oil-pressure gages, are overhauled in another department, which employs thirty highly skilled instrument makers. The sheet-metal and welding department, shown in Fig. 6, employs approximately ninety men, who are engaged in diversified fabricating activities on both aluminum and steel. Heat-treating facilities are provided in this department for aluminum alloy products. Adjacent to this department is a room in which lead and zinc dies are produced for shaping the sheet metal, and there is also an electroplating room.

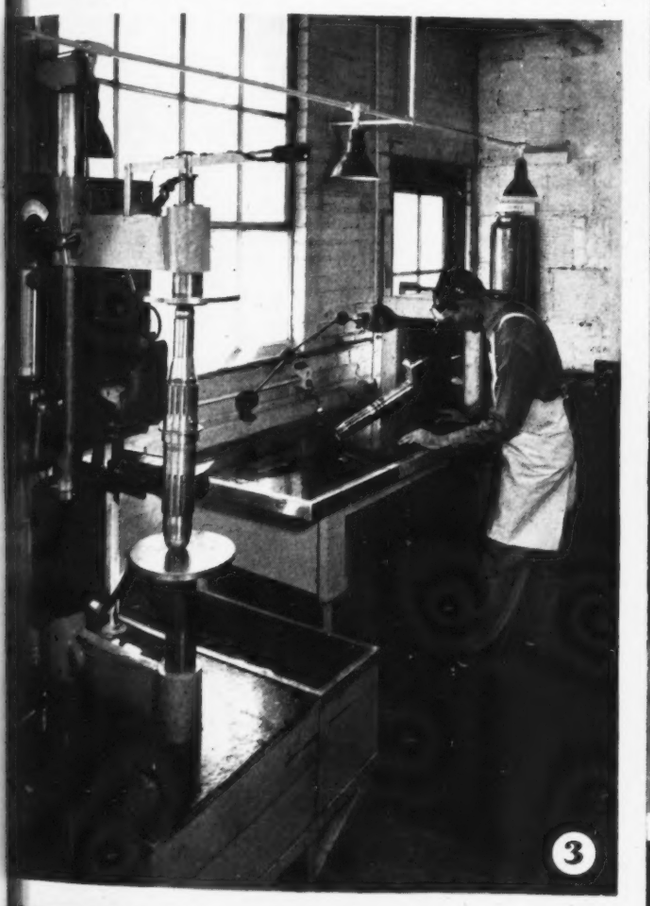
Accessories, such as generators, spark plugs, magnetos, thermostatic units, and pumps, are overhauled in a shop that is equipped with a large number of special testing machines and devices. Twenty-three mechanics are employed in this department. There is also a radio-electric shop, which takes care of radio transmitting and receiving sets, generating systems, microphones, and other electrical accessories.

The propeller and battery department, shown in Fig. 5, employs another sixty men. Here defective propeller blades and other parts are replaced with new parts, and after assembly, the units must meet the same rigid static balancing requirements observed in regular propeller manufacturing plants.

In addition to the various departments already mentioned, there is one devoted to the overhauling of cabin equipment. Finally, there is a store-room for materials and manufactured parts, employing about forty persons.







Forgings for a

Fig. 1. Rough-forging a Square Billet to the Approximate Outline of a Landing-gear Fork

THE production of steel forgings for the aircraft industry is an interesting story of one of the oldest mechanical arts serving one of the newest. Just as the advent of the Machine Age with its new problems provided impetus for the step from the age-old art of blacksmithing, or hand forging, to drop-forging—and as the automobile industry, in turn, caused the advancement of forging practice to a still higher plane of accomplishment—so the aircraft industry requires a new forging technique to insure the highest degree of dependability in parts which effect the structural safety of aircraft.

Forging for the aircraft industry differs vastly from ordinary forge shop practice. To begin with, every steel forging must pass a Magnaflux test that exposes hidden laps, seams, or cracks. Each forging also must be made with one or more test pieces that can be broken off for subjecting them to physical tests and metallurgical investigations. To make certain that specifications are being met and the desired grain structures obtained, it is customary to perform such tests on one piece in the metallurgical laboratory of the forge shop and on another sample when the part reaches the engine or plane plant. Sample forgings are also sawed through various sections to determine grain flow characteristics.

Maximum strength with minimum weight is always the prime objective of the aircraft industry, and when it comes to forgings for use on the planes themselves, it is not unusual to find specifications insisting upon ribs only 3/32 inch and even 1/16 inch in thickness. Such extremely thin sections on parts perhaps 2 to 3 feet in length obviously create difficult forging problems. Dimensional tolerances are often held to plus or minus 1/32 inch. Close matching of dies is another exacting requirement. Fillets, too, are generally of such small radii as to make it difficult to cause the metal to flow into deep recesses in the die impressions.

Complex design makes the forging of many airplane parts a difficult problem, due to the fact that one forging may be intended for a multiplicity of functions and therefore requires a considerable number of arms, lugs, or bosses. In preliminary plane designs, these complicated parts are generally built up by welding plates and blocks of steel together, and when the plane is placed in production, the forge shop is asked to furnish the same parts without any increase in weight or dimensional differences. Examples *A*, *C*, *D*, *E*, and *G* in Fig. 3 are typical forgings of this type, all of which have been produced in the forge shop of J. H. Williams & Co., Buffalo, N. Y.

Coupled with the foregoing factors are the tough materials from which aircraft forgings are produced. Chromium-molybdenum steel is used for most plane forgings, Nitralloy steels for cylinder barrels, and chromium-nickel-molybdenum steel for propeller hubs and some other forgings. Every airplane forging is designed to carry a heavy load,

Fig. 3. Many Airplane Forgings are Characterized by Extremely Thin Webs and a Multi-

and contrary to practice in other fields of engineering, it is not possible to allow a large factor of safety. In fact, a penalty is generally imposed on plane builders for every pound that a plane weighs in excess of the specified weight.

The landing-gear fork shown at *B* in Fig. 3 will serve to illustrate some of the problems involved in the forging of parts for airplanes. This fork is produced from a billet 6 1/2 by 3 1/2 inches in cross-section by 16 1/2 inches in length and weighing 90 pounds, although after the removal of metal in the forging and machining processes, the weight of the finished part is only 12 1/2 pounds. While such a part could be easily forged from carbon steel, forging it from chromium-molybdenum steel is far more difficult, due to the fact that this alloy flows less readily into the die impressions. Seams and cracks tend to develop if the steel is not worked with great care, and these must be eliminated in order that the forging may pass the Magnaflux inspection.

The billet of steel for the landing-gear fork is heated to from 2150 to 2200 degrees F. for forging operations. Preliminary work is performed on the single-leg steam hammer shown in Fig. 1, where one end of the billet is split by means of a mandrel and gradually forged into two long prongs between flat dies. The stock is reheated several times during this process. After rough-forging to the approximate shape, the part is finish-forged under the 7000-pound steam drop-hammer illustrated in Fig. 2.

Although this forging is approximately 35 inches long over all by 13 inches wide, the various sections are held to size within plus or minus 1/32 inch. The I-shaped arms have webs only 5/32 inch thick. This means that a large amount of stock must be displaced in forging this part and a difficult problem is presented due to the fact that the thin sections of the arms cool much more rapidly than the large-diameter opposite end of the forging. Four reheats and four hot trimming operations are consequently required during the forging process. In reheating the forging, as in the original heating, the furnace temperature is carefully controlled to prevent overheating and to minimize oxidation or scaling.

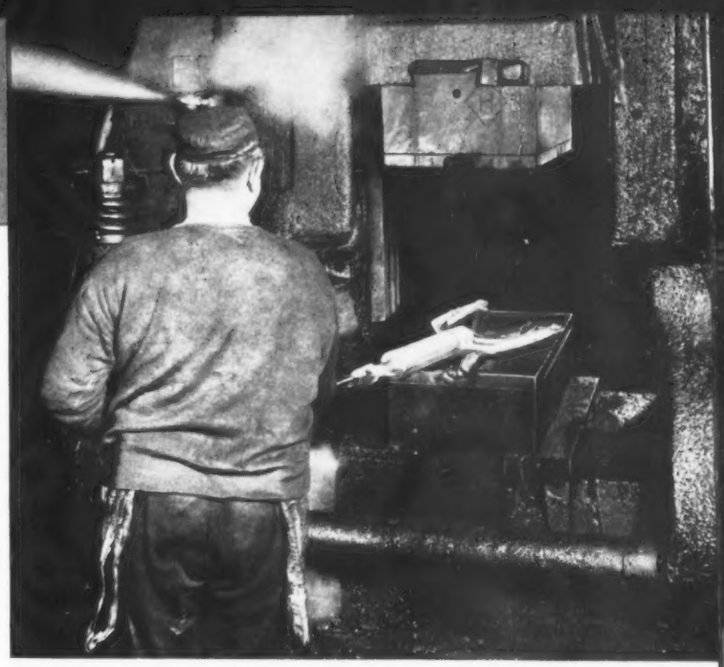


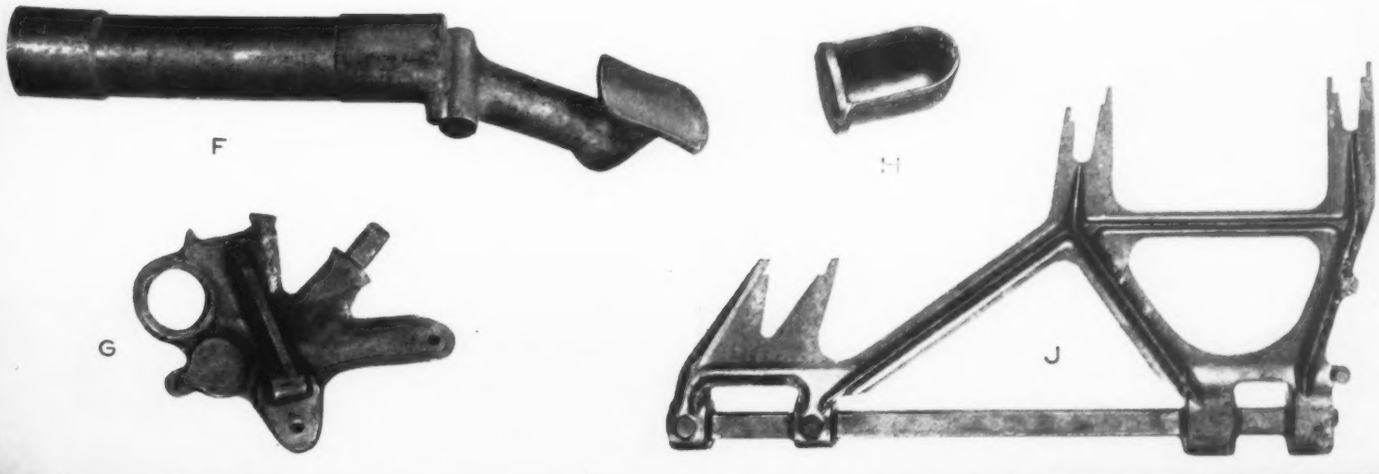
Fig. 2. Finish-forging the Landing-gear Fork under a 7000-pound Steam Drop-hammer

There is only one impression in the die, which is the case with many airplane forgings, due to the fact that only twenty-five or fifty forgings may be required, and therefore, the die cost must be kept as low as possible.

In the original design of this fork the fillets were only of 1/8-inch radius and the ribs narrow and deep, requirements which made forging to specifications in a single die impression almost impossible. With the granting of permission to increase the fillets to larger radii, the forging of this part became practicable. Near the outer end of each prong may be seen a test piece for investigating the physical properties of each fork.

The landing-gear cylinder shown at *F* presented

plicity of Arms and Bosses which Enable One Forging to Take the Place of Several



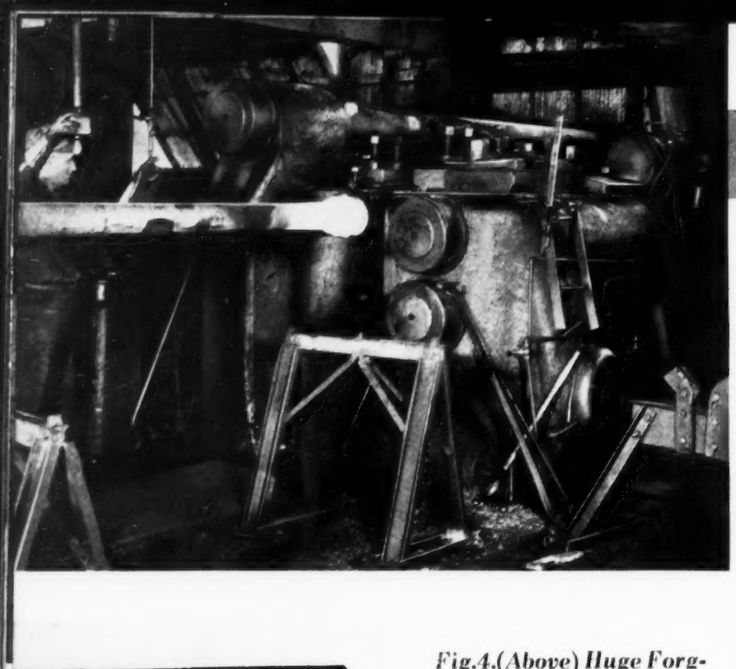


Fig.4.(Above) Huge Forging Machine which Produces Airplane Cylinder Barrels from Bars of Nitralloy Steel in the Successive Stages Indicated in Fig. 5

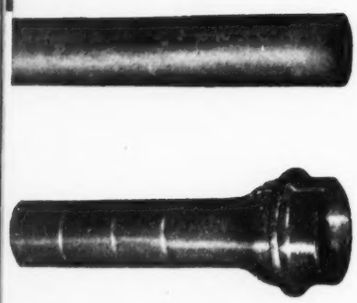
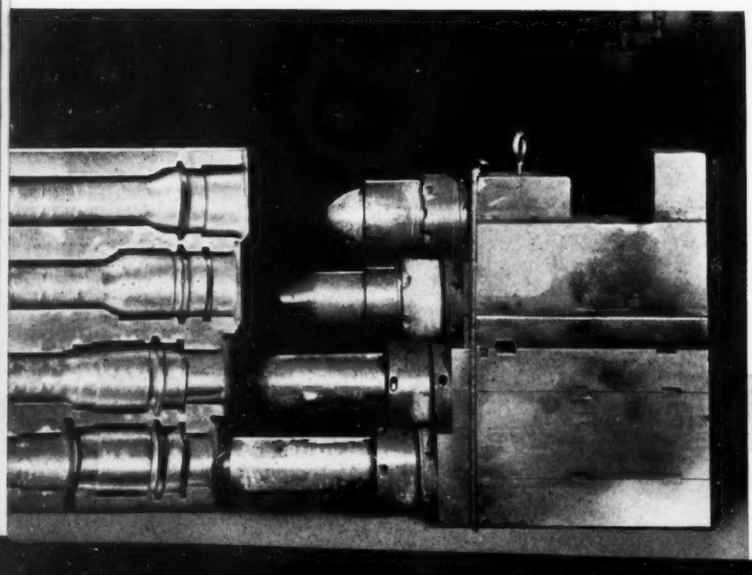


Fig. 5. (Left) The Four Steps in the Forging of Airplane Cylinder Barrels from Nitralloy Steel Bars by the Machine Shown in Fig. 4.

Fig. 6. (Below) One Half of the Dies and the Punches which are Provided on the Forging Machine for the Production of Cylinder Barrel Forgings



problems due to the necessity of forming the flange at one end and also a tapered boss only 1 inch in diameter by 1 1/2 inches high near the middle of the part. The flange had to be forged at right angles to the adjoining section and it is only 1/4 inch thick by 7 inches long. In the case of both the flange and the tapered boss, it was extremely difficult to force the metal into the narrow die impressions.

Limits of only plus or minus 1/32 inch were also specified for the diameters, straightness, etc., of this piece, which is 35 inches long over all. It is bored and turned in the airplane shop to such a thin shell that if the forging is not true within close limits, the long bore will be machined through the wall. In this case a billet weighing 205 pounds is necessary for a part that weighs only 25 pounds when installed on an airplane. Most of the machining consists of boring operations.

This part was forged by J. H. Williams & Co. from chromium-nickel-molybdenum steel of an air-hardening variety. During the forging operation, which was performed in a finishing die only beneath a 7000-pound steam drop-hammer, the forging had to be heated three or four times and hot trimmed as many times. Folds that started during the forging were chipped out to insure a satisfactory job.

The forging at *H* in Fig. 3 is of especial interest because the wall thickness is only 1/8 inch and the part is of considerable depth. Any mismatching of dies in the production of this part would result in rejected work. The example at *E* is a forging that really combines several distinct parts into one. This forging is characterized also by thin ribs, thick sections, corners, and twists that tend to develop cold shuts. It is hammered from a block of steel to a rough outline in a blanking die and then drop-forged in a finishing die.

The forging at *J* is another excellent example of extremities in design that must be met by the forge shop that supplies parts to plane manufacturers. This forging is approximately 18 inches long by 12 inches wide, and in its production only a couple of pounds of metal had to be spread over the area indicated by these dimensions. The ribs and projecting fingers are only 1/8 inch thick. In the forging of such thin sections, there is always a tendency for the metal to move in the direction of the die faces and out into the flash, instead of into the shallow die impressions where it is desired.

An outstanding forging job at the Canton Drop Forging & Mfg. Co., Canton, Ohio, is the production of cylinder barrels from bar stock in the huge

National forging machine illustrated in Fig. 4. These cylinder barrels are forged from bars of Nitralloy steel 5 1/2 inches in diameter and 18 to 20 feet in length.

They were originally forged from extruded billets with a waste of over 80 per cent of the material, as well as time. The bars from which the cylinder barrels are now forged are produced at the steel mill with the greatest of care and under a rigid inspection, which involves heavy croppage of the billets and, in some cases, rolling of a "pilot lot" of bars in order to determine the quality of the heat before the remainder of the bars are produced. Finally, there is an inspection which consists of sawing a disk from each bar and grinding, polishing, and etching the disk to determine the grain structure.

The successive steps in the forging of the cylinder barrels is indicated in Fig. 5. With the heated stock in the upper impression of the dies, which are illustrated in Fig. 6, the end of the bar is upset and the hole partially formed. Then in the second impression from the top, the bar is further upset and the hole formed to a greater depth. The upsetting operation is practically completed in the third impression, and in the fourth impression the forging is severed from the stock by a piercing punch.

Prior to the forging operation, the bars are thoroughly and uniformly heated in oil-fired furnaces, and they are reheated in the production of each subsequent forging. The forgings are annealed to obtain maximum machineability. They are rough-turned at the forge shop so as to enable a much closer inspection than is possible with a rough forging, and also to reduce the shipping weight. The forgings finally undergo a rigid inspection for size and for surface imperfections. The extent of any imperfections must be determined and the defects completely removed.

One of the latest developments in airplane engine construction has been the adoption of steel forged crankcases. These crankcases are forged in two halves for single-row engines. In Fig. 7 one of these crankcase halves is being finish-forged beneath a 12,000-pound steam hammer, also in the shop of the Canton Drop Forging & Mfg. Co.

Crankcase forgings are produced in diameters up to 27 1/4 inches and in widths up to about 8 inches. A dimensional tolerance of only 1/8 inch per side is specified for these large forgings. At the end of the forging operation the crankcases are heat-treated. They weigh up to approximately 250 pounds.

The forging of a solid hub for a triple-blade airplane propeller is illustrated in Fig. 8. These hubs range in weight from 300 to 550 pounds as forged. Each forging is marked to identify the section of the individual billet from which it was produced, and a cross-sectional slice is taken from the adjoining stock of the billet for test purposes. In addition, after heat-treatment, two test specimens are cut from the tong hold of each forging, one for a Magnaflux test and the other to check the physical properties specified.

Fig. 7. Steel Crankcase Forgings up to 27 1/4 Inches in Diameter have been Produced by the Canton Drop Forging & Mfg. Co.

Fig. 8. Solid Triple-blade Propeller Hubs Ranging in Weight from 300 to 550 Pounds are Forged under This 12,000-pound Steam Hammer

Unique Cylindrical Grinding

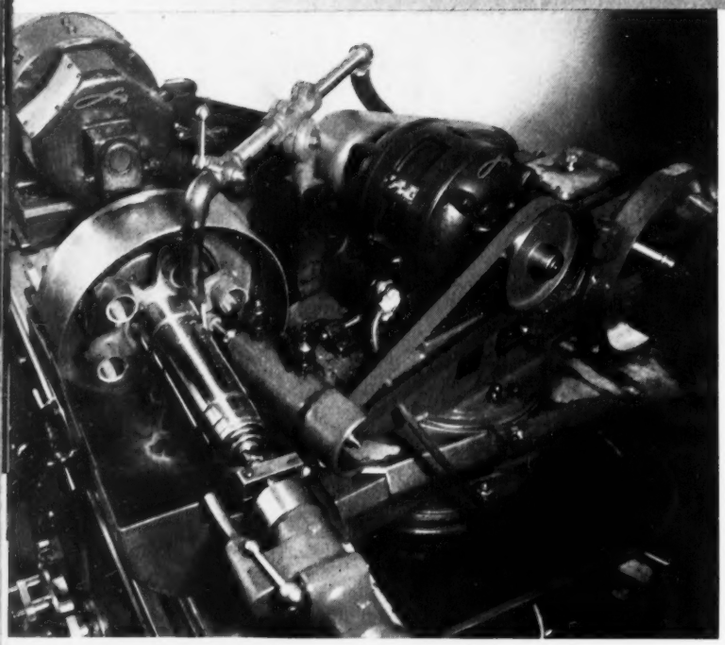


Fig. 1. Many Grinding Operations in Airplane Engine Plants are Similar to the Practice Followed in Other Metal-working Shops. There are, However, Some Parts Peculiar to Radial Aircraft Engines which Require Special Machines or Fixtures, or Unusual Adaptations of Standard Equipment. In the Operation Here Shown, a Wheel of Unusually Small Diameter is Necessary for the Cylindrical Grinding of a Reduction-gear Spider Hub, because of the Small Space between the Pinion Bearing Bosses and the Hub. The Equipment in This and Following Illustrations was Furnished to Various Airplane Manufacturing Plants by the Norton Co., Worcester, Mass.

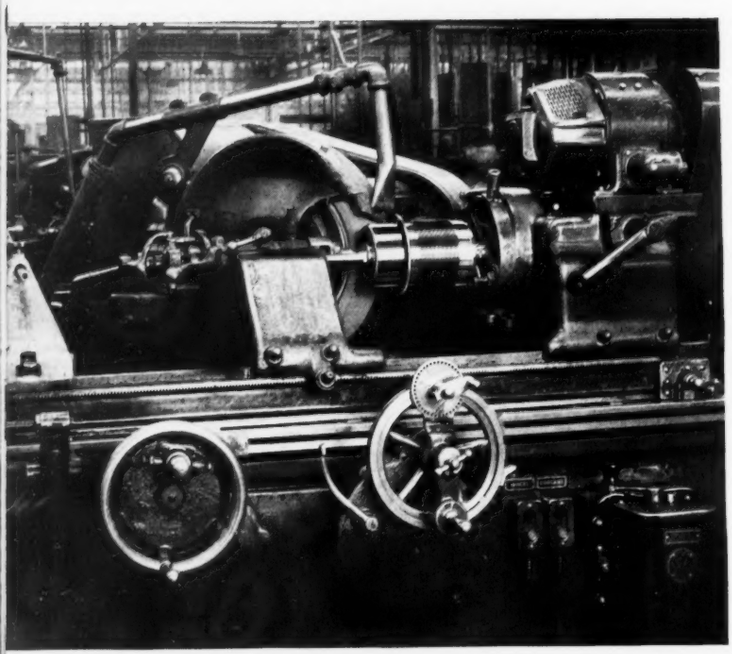


Fig. 2. Grinding the Cylindrical Crankcase Fit on a Cylinder Barrel and also the Face of a Flange in One Operation by Employing a Wheel that is Dressed to a 90-degree Vee. By Operating the Wheel at an Angle, One Side of the Vee Grinds the Crankcase Fit and the Other the Flange Face, a Method that Insures Squareness of the Flange Surface within a High Degree of Accuracy. The Chromium-molybdenum Steel Cylinder Barrel is for a Pratt & Whitney "Twin Wasp Junior" Engine

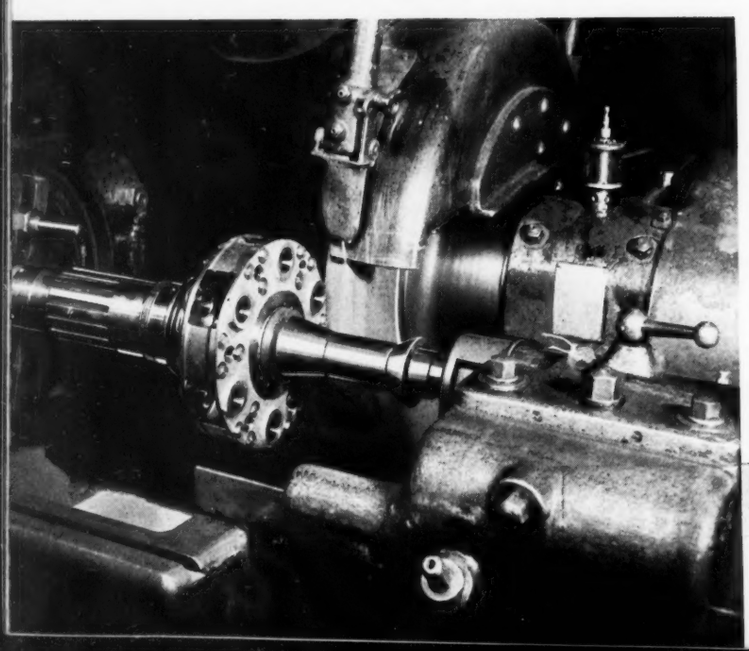


Fig. 3. Grinding the Outside Diameter and Outer Ends of Pinion Shaft Bosses on the Reduction-gear Cage Housing that Goes on Pratt & Whitney Fourteen-cylinder Wasp and Hornet Engines. The Outside Diameter is Ground with the Periphery of the Wheel and the Boss Ends with the Side of the Wheel, Square within Extremely Close Tolerances. Special Centers are Used for Holding the Work

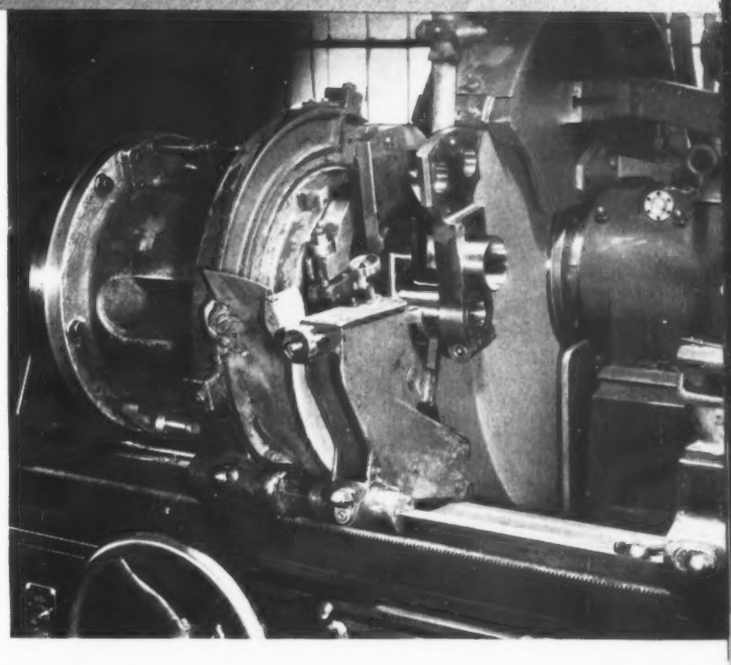


Fig. 4. Finish-grinding the Crankpin of an Assembled Crankshaft for a Wright Whirlwind Engine on a Special Machine. The Crankshaft is Supported by a Work-holder Attached to the Flanged End of a Heavy Spindle. An Outboard Bearing Mounted on the Machine Table Provides Additional Support for the Long Work-holder. A Clamp that Closely Fits the Bearing Adjacent to the Crankshaft Flange and a Center Point at the Rear of the Work-holder Maintain Alignment of the Crankshaft. A Grinding Wheel 42 Inches in Diameter is Necessary for This Job because of the Projecting Flanges of the Crankshaft. The Diameter of the Crankpin is Held within a Total Tolerance of 0.0002 Inch

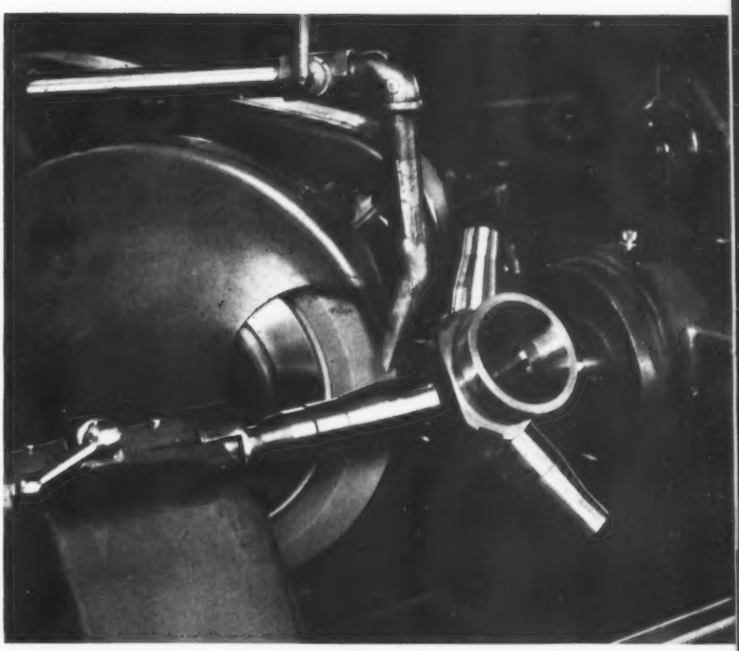


Fig. 5. A Grinding Machine with the Wheel on an Angular Slide, as in the Case of the Machine Shown in Fig. 2, is Used in Grinding the Large Bearing, Fillet, and Square Shoulder on the Blade Arm of Hamilton Standard Propeller Spiders. The Work is Mounted on Centers, an Adapter being Inserted in the Open End of the Blade Arm. The Large and Small Bearings of This Spider Must be Concentric within 0.0005 Inch According to Indicator Readings; the Total Tolerance for Diameters is also 0.0005 Inch

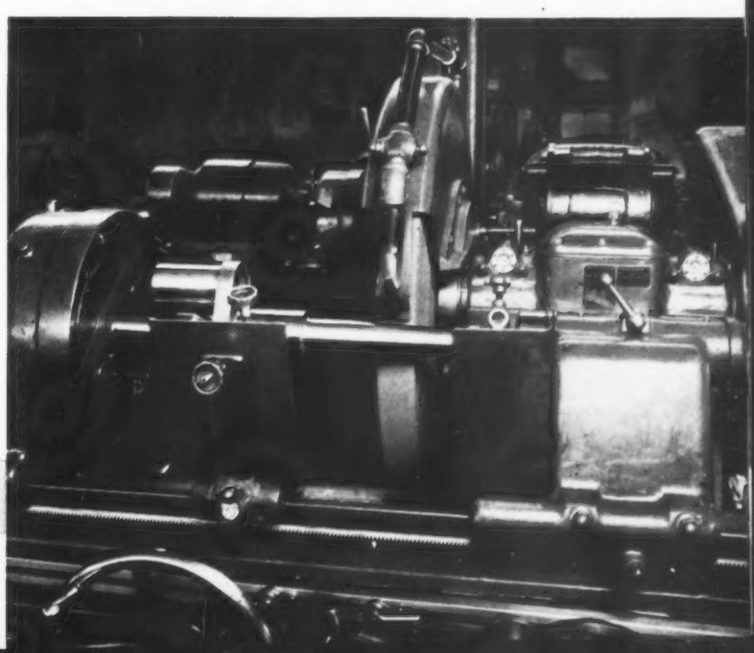


Fig. 6. Taper-grinding Operation on a Machine that is One of a Number that have been Supplied for the Grinding of Bearings, Gear Diameters, Surfaces to be Threaded, Tapers, etc., on the Crankshaft for a Radial Engine of American Design which is to be Manufactured in Soviet Russia. The Work-table, with the Headstock and Footstock, is Swiveled to the Required Angle in Grinding Tapers, as on Standard Machines

Propeller Hubs and Spiders

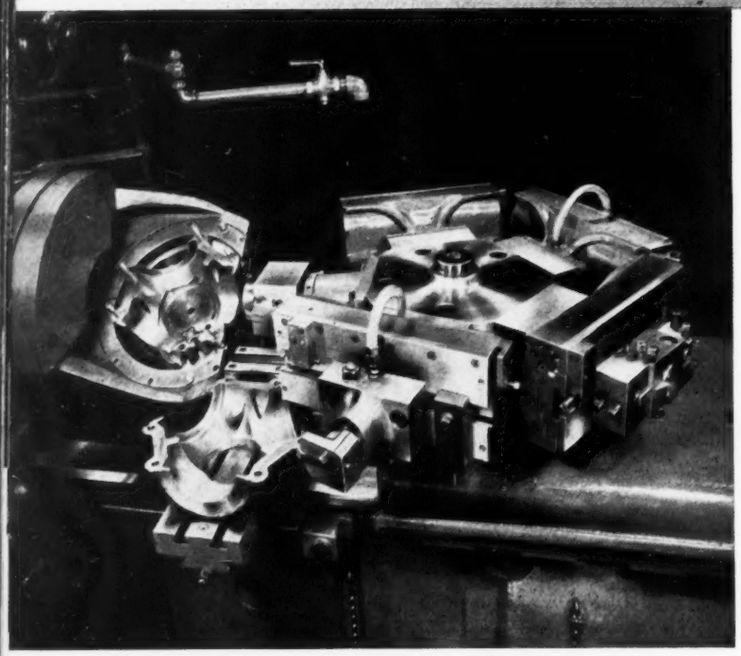


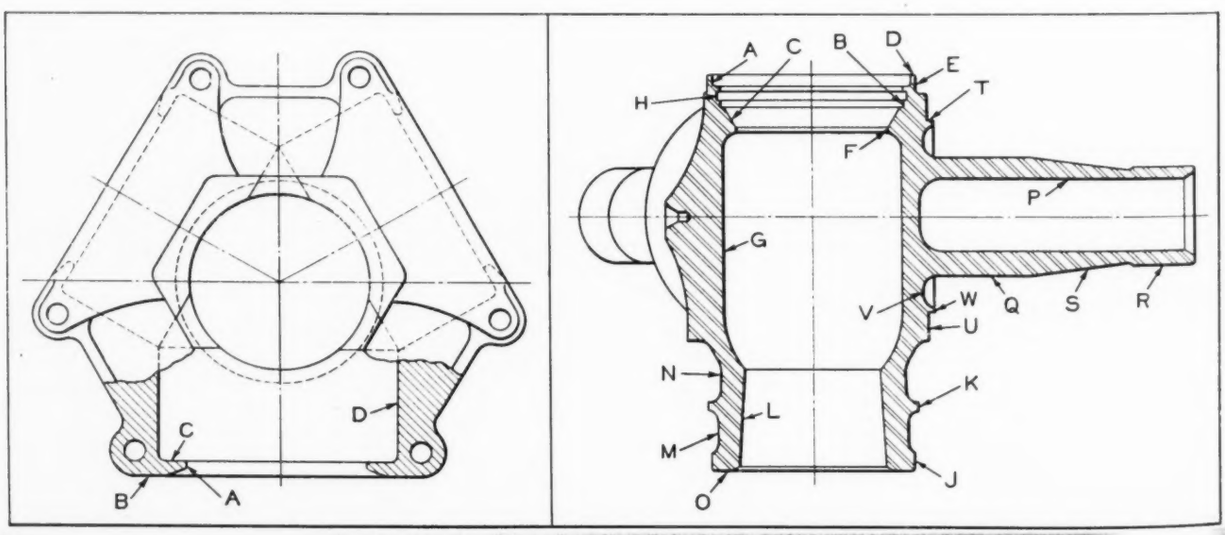
Fig. 1. Tooling Provided on a Potter & Johnston Automatic Chucking Machine for Machining Propeller Hub Forgings

Fig. 2. Drawings of Hub and Spider Forgings which Indicate the Surfaces Machined in the Operations Described

PRODUCTION requirements in the aircraft industry have now reached the point where the use of high-production equipment in the manufacture of quite a few parts has shown decided economic advantages. For example, in the Hamilton Standard Propellers Division of the United Aircraft Corporation, East Hartford, Conn., and in other plants throughout the world producing the same propellers under license, a number of important operations on propeller hubs and spiders are performed by Potter & Johnston automatic chucking and turning machines. These operations are of particular interest because of the combination of factors involved, such as the parts being alloy steel forgings having high Brinell readings, the large amount of stock to be removed, the close dimensional tolerances to be maintained and the fine finish required.

Hubs for the Hamilton Standard controllable-pitch propellers are made in two sections which are bolted together when they are assembled into the propeller unit. They are bolted together for the operation performed in the Potter & Johnston automatic shown in Fig. 1, the two halves first being ground on their faces to enable solid assembly and also drilled and tapped to receive the six studs by means of which the halves are bolted to each other.

The illustration shows the hub halves at the end of the operation performed by the machine. The tools on the first face of the turret rough-bore opening *A* (see left-hand view of Fig. 2) in one of the hub barrels and also machine the adjacent beveled surface toward the outside of the forging. Then the turret is indexed to bring the second face toward the work for rough-straddle-facing surfaces *B* and *C*. These cuts are taken by means of slide



tools fed radially after the turret has been advanced to the required point for positioning the tools in line with the surfaces to be machined.

A single-point tool on the third face of the turret is next employed to rough-bore hole *D*, this tool also being mounted on a slide. For this cut the turret is first advanced at a fast rate until the boring tool clears surface *C*. Then with the turret dwelling, the slide moves the boring tool radially to surface *D*, the tool-slide coming into contact with a stop. The turret is then again fed forward for taking the cut.

Slide-tools on the fourth face of the turret next finish the surfaces *B* and *C*, and also form the rounded corner of hole *A*. Finally, a single-point tool on a slide mounted on the fifth turret face finish-bores hole *D* to size within plus 0.005 inch minus 0.000 inch, the nominal diameter on a typical hub being 7.250 inches and the length of the bore 3 1/2 inches.

After one hub barrel has been completely roughed and finished as outlined, the hub halves are reset in the chuck for machining the second barrel and after that, the third. The floor-to-floor time required for completely machining the two halves is approximately three hours. Cutting speeds range from 30 to 70 feet a minute and feeds from 0.007 to 0.013 inch. The average depth of roughing cuts is 3/16 inch and the stock left for the finishing cuts is 0.032 inch on a side.

Three-arm spider forgings of the type shown diagrammatically at the right in Fig. 2 are finished all over in four chuckings in Potter & Johnston automatics. The machine shown in Fig. 3 is used for the first chucking. The spider is gripped between the arms and is held with the short hub toward the turret tools. A hole 2 3/4 inches in diameter is drilled through the hub before the part is brought to this machine.

Tools on the first turret face rough-bore surfaces *A* and *B*, rough-machine the tapered surface *C*, rough-face end *D*, and rough-turn surface *E*. At the same time a spot is faced on each of the three arms by means of a tool on the front cross-slide, for locating purposes in subsequent operations. Tools on the second turret face then bore hole *F*, take a second cut on surface *E*, and chamfer the hub end.

The third face of the turret is equipped with a slide-tool for removing the surplus stock from hole *G*, the tool being withdrawn radially near the end of the cut to obtain the required shape. Tools on the fourth face of the turret finish-bore surfaces *A*

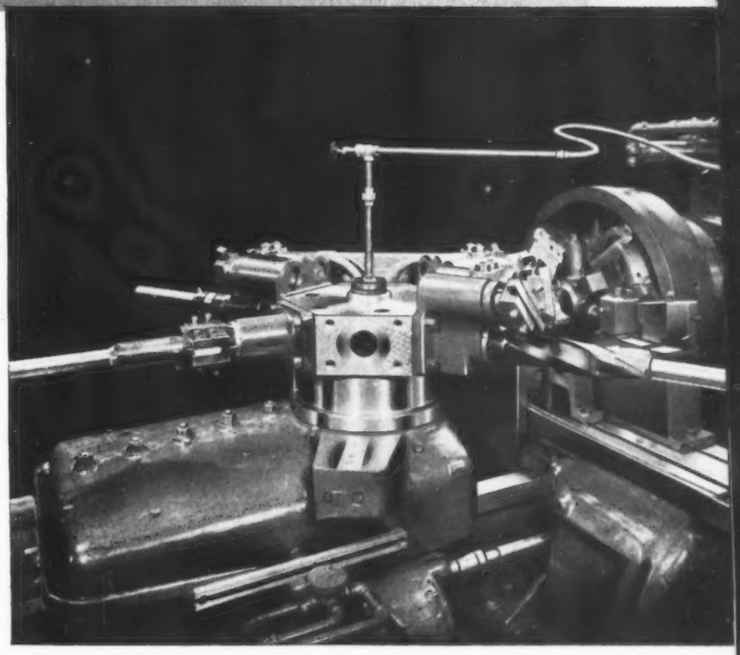
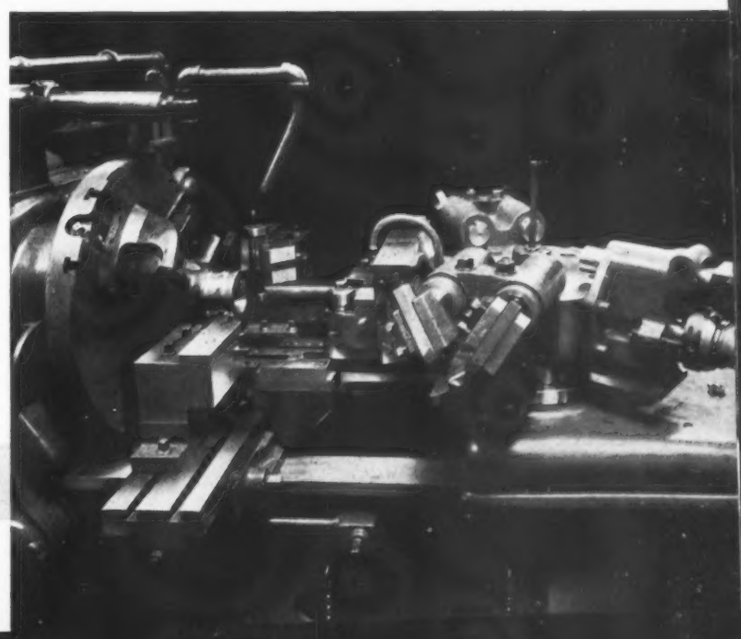


Fig. 3. Equipment Used in the First Chucking of a Propeller Spider Forging in an Automatic for Both Roughing and Finishing the Short Hub

Fig. 4. The Second Automatic Operation on the Propeller Spider Consists of Machining the Bores and External Surfaces on the Long Hub



and *B*, semi-finish taper *C*, bore hole *F*, and chamfer various corners. At the same time a tool on the rear cross-slide finish-faces the three arms. Tools on the fifth turret face then finish-bore hole *F*, finish taper *C*, finish-turn surface *E*, and finish-face surface *D*. Finally, a tool on a slide mounted on the sixth turret face cuts recess *H*. The average floor-to-floor time per piece is two hours and ten minutes.

For the second chucking on the spider, use is made of an automatic equipped as shown in Fig. 4. The work is located by seating the finished surface *E* in a ring and clamping the finished end *D* against three steel buttons. The spider is driven by the action of dogs against the three arms. The illustration shows the turret positioned with its second face toward the work.

In this chucking, tools on the first turret face rough-turn surfaces *J* and *K* and rough-machine the tapered hole *L*. After the turret is indexed, tools on the second face machine bore *G* for its entire length, including the rounded portion that leads to hole *L* and the small fillet on the opposite end, the latter cut being taken with a single-point tool mounted on a turret slide.

Tools on the third turret face next finish-turn surfaces *J* and *K* and finish-form the tapered hole *L*. Then, with this hole supported by a receding plug center, such as seen on the turret face at the right in Fig. 4, grooves *M* and *N* are rough-formed and end *O* rough-faced by cutters mounted on the front cross-slide. With the work similarly supported, tools on the rear cross-slide then advance to finish-form these grooves and finish-face end *O*. A chamfering tool mounted above the receding center support bevels the end of the hub. The time per piece in this chucking is approximately two hours.

Both hubs are now finished and the following operations in automatic chucking and turning machines rough and finish the three arms. For both the roughing and finishing chuckings, the hub ends of the spider are located on an arbor and sleeve, and two arms are held in position by bell centers, as may be seen in Fig. 5. The spider is clamped on the hub ends by tightening a nut against the outer side of one of the work fixture bosses.

Tools on the first turret face of the machine shown in Fig. 5 drill hole *P*, from the solid stock, to a diameter of 1 9/16 inches in the case of one spider and to a depth of 2 3/8 inches, rough-turn the large diameter *Q* and bevel the outer end of the arm to cut away tough skin preparatory to a subsequent turning cut. Tools on the second turret face complete the drilling of hole *P* and rough-turn surface *R* and taper *S*.

Tools on the third turret face then semi-finish-drill hole *P*, form the bottom of this hole, and rough-turn taper *S* and surface *Q*. The fourth turret face tools next rough-turn shoulder *T*, face surface *U*, and form under-cut *V*. Finally, tools on the fifth turret face semi-finish-turn surfaces *Q* and *R*, bevel the outer end of hole *P*, and round the end of the arm. The average floor-to-floor time for machining all three arms of a spider is approximately three hours.

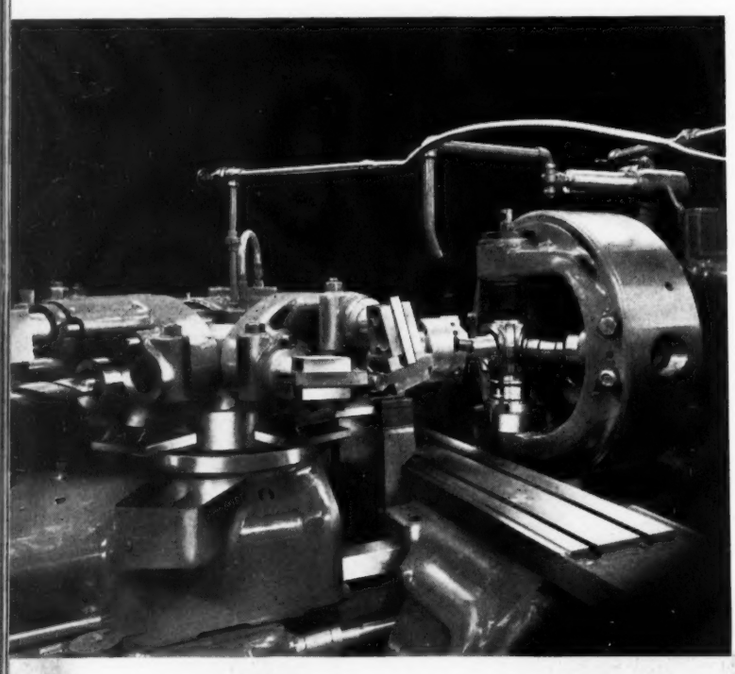


Fig. 5. Tooling Employed on an Automatic Chucking and Turning Machine for the Taking of Roughing and Semi-finishing Cuts on All Three Arms of a Propeller Spider

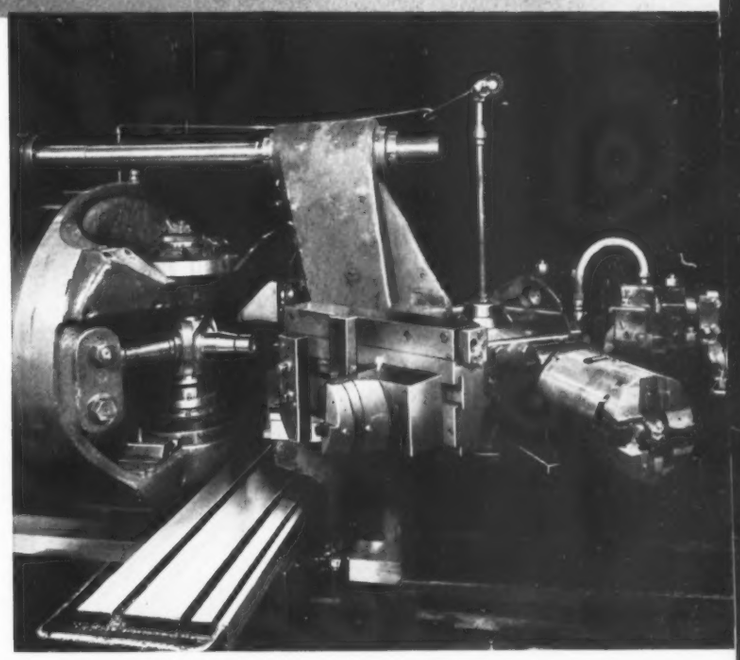


Fig. 6. Set-up Employed on an Automatic for Taking the Finishing Cuts on the Spider Arms and for Machining Center Holes in the Body between the Arms

The final cuts on the spider arms are taken in a machine set up as shown in Fig. 6, this chucking being performed after splines have been broached in the tapered hole *L*. The spider is located from these splines in a chuck similar to that of the preceding operation and centered by a plug that fits taper *C*. The arms are positioned by entering plugs into hole *P* of two arms.

Tools on the first face of the turret on this machine finish-bore hole *P*, finish-turn surfaces *Q* and *T*, and chamfer and face the end of the arm. Tools on the second turret face then finish-turn taper *S* and surface *R*, after which tools on the third turret face ream hole *P*, form the bottom of this hole, finish-form under-cut *V*, and finish-face surface *W*. Face *U* of the propeller spider is next finished with a single-point cutter that is mounted on a slide tool on the fourth face of the turret.

While the turret is next held rigidly in line with the chuck by means of an overhead pilot bar, as shown in Fig. 6, the beveled seat in the end of the arm is accurately finished. At the same time a center hole is drilled into the body of the spider directly in line with the arm that is toward the turret and between the other two arms, by means of a center drill that is advanced from the headstock. Finally, this hole is bored with a single-point tool mounted on the sixth face of the turret after the fixture has been manually indexed to bring the center hole toward the turret. A lock bolt insures positive alignment of the center hole and the beveled seat that has just been finished in the end of the opposite arm. The floor-to-floor time consumed in finish-machining the three arms of the propeller spider by employing this set-up amounts to approximately three hours.

Accuracy is Paramount in

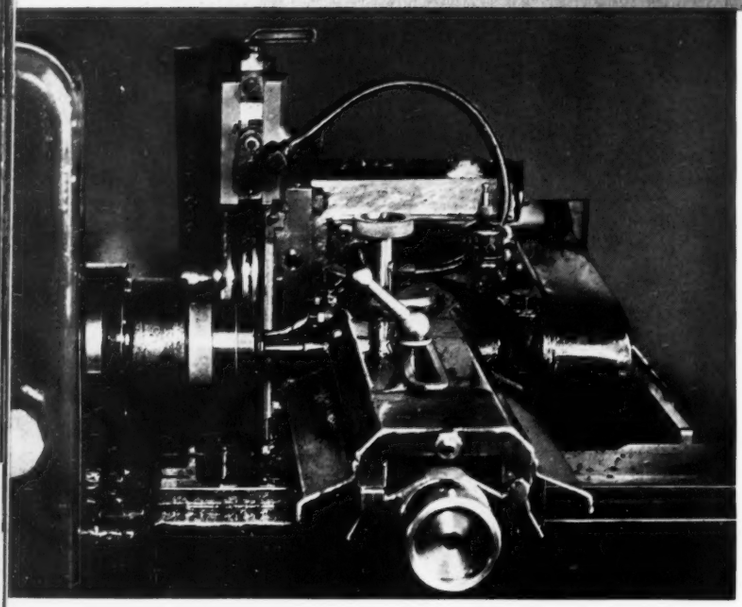
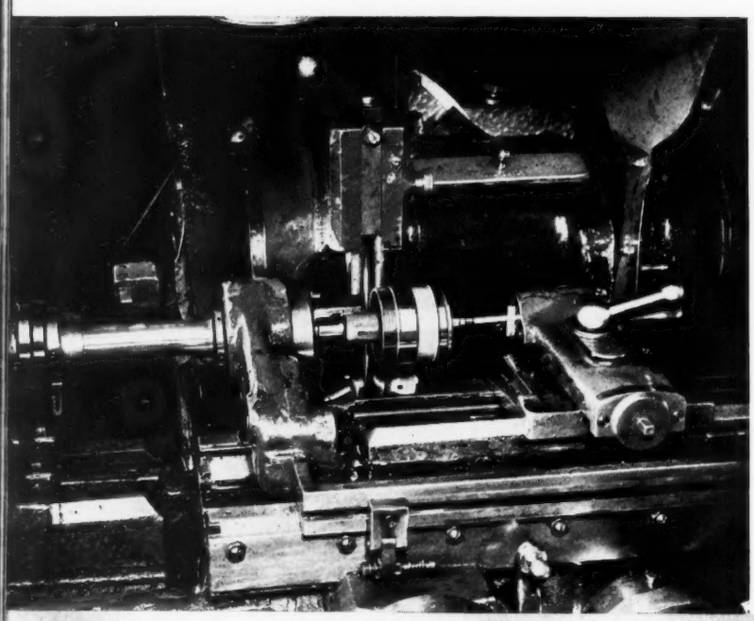


Fig. 1. Grinding an Internal Thread on a Clutch Barrel for Airplane Starters after Hardening to Obtain the High Degree of Accuracy that is Specified

Fig. 2. Grinding an External Thread on the Outside of the Clutch Barrel Rim in which an Internal Thread is Shown Being Ground in Fig. 1



STARTERS for aircraft engines are important products in the extensive line of accessories for the airplane industry that is manufactured by the Eclipse Aviation Corporation, East Orange, N. J. Five different types of starters are produced—inertia, direct-cranking electric, combustion, air injection, and hand-turning gear.

Inertia starters are made with a small flywheel that is accelerated to a high speed either manually or electrically, and the stored energy is applied to rotate the engine crankshaft. The direct-cranking electric starter consists basically of an electric motor, a gear reduction, and an automatic clutch engaging and disengaging mechanism. The engine is turned over directly by the starter, which provides continuous cranking until the engine operates by itself.

Combustion starters incorporate a small breech that is loaded with an explosive shell resembling the shell for a shot-gun. When this shell is exploded electrically, cranking torque is applied to the engine crankshaft through the operation of a piston, screw mechanism, and jaw-tooth clutch. This type of starter is particularly suitable for single-engine military planes because it provides instantaneous starting with minimum battery usage.

The air injection starter is intended for application to engines of low horsepower rating and is particularly suitable for use where an electric installation or manual cranking is undesirable. The air injection starter has a small engine-driven air compressor that supplies an initial pressure of 450 pounds per square inch for cranking the engine. The hand-turning gear starter is also intended for use with engines of low horsepower not equipped with batteries. Gearing reduces the manual effort required for turning over the engine.

The close limits of accuracy and high quality of workmanship that are demanded in the manufacture of airplane engines, propellers, and instruments, also prevail in the production of starters. For example, Fig. 1 shows an Ex-Cell-O thread-grinding machine being used for grinding an internal thread in a thin rim of comparatively large diameter on the end of a clutch barrel. This rim is less than 1/8 inch thick and, in addition, has a slot 1/4 inch wide extending from the end for a length of approximately 1/2 inch. A thread is also ground on the outside of this ring.

The pitch diameter of the internal thread is held to between 3.0043 and 3.0066 inches, the thread being of U. S. Standard form, twenty-four per inch.

The external thread must be held within a comparable tolerance. The thin wall and the slot made it practically impossible to finish these threads to the required accuracy until they were produced by grinding, due to the distortion which resulted from heat-treating the part after the threads had been cut. Thread grinding was adopted because it permits the threads to be ground from the solid after hardening, and distortion is, therefore, avoided. Fig. 2 shows the large diameter external thread being ground.

In addition to the internal and external threads on the large end of this part, threads of twenty-four per inch are also ground on the 9/16-inch diameter stem that is seen extending from the chuck end in Fig. 2. The part is a nickel-chromium-steel forging. All of these threads are ground in two passes of the wheel, from 0.005 to 0.006 inch of stock being left for the finish-grinding. The wheel is dressed between the first and second passes. The finished threads are inspected by means of "Go" and "No Go" gages. Threads are also ground on a considerable variety of other parts, including clutch adjusting nuts, stainless-steel needle valves, and combustion starter cylinders.

Prior to the heat-treatment and the thread-grinding operations, the clutch barrel is machined all over in two Fastermatics. In the first operation, the inside surfaces are bored and the one end is faced. The second operation, illustrated in Fig. 3, consists of roughing and finishing the external surfaces. In this operation, tools on the rear cross-slide rough-form the large-diameter cylindrical surfaces of the barrel and also the stem, and the tools on the front cross-slide finish-form the barrel surfaces and finish-face the closed end of the part. A tool on the hexagonal turret, however, rough-faces the closed end before the front cross-slide feeds in, this cut being taken the full width of the surface. Other tools on the turret turn and chamfer the flange and recess the closed face.

The cylinders for the combustion starters are forgings of stainless steel approximately 8 1/4 inches long over all by 4 1/2 inches in diameter. After being rough-bored in a turret lathe, they are turned in the Carbo-Lathe shown in Fig. 4. The turned surface of the particular cylinder illustrated tapers from the closed end toward the opposite end, although on another style of cylinder the surface is tapered from both ends toward the center. After this turning operation has been performed, the part is finish-bored in an adjoining Carbo-Lathe and then honed in a Barnes Drill Co.'s machine. The Carbo-

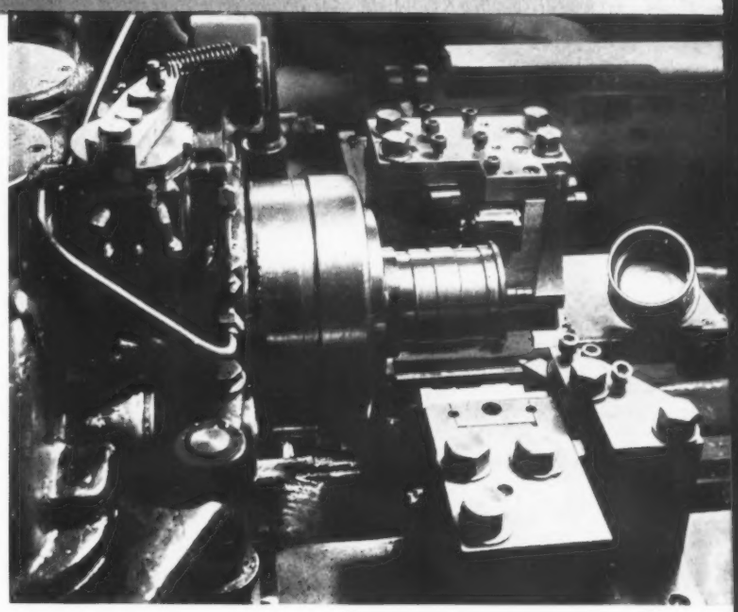
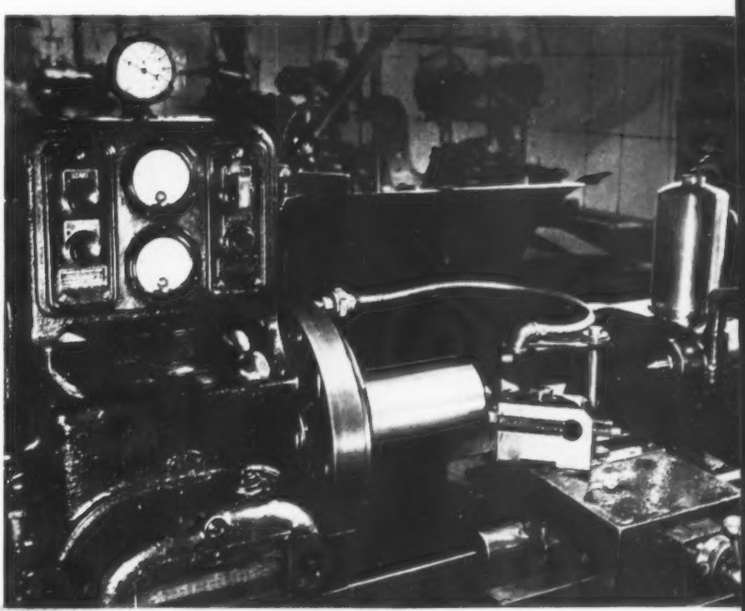


Fig. 3. Machining the External Surfaces of the Clutch Barrel in a Fastermatic Preliminary to the Grinding Operations which Precede Thread Grinding

Fig. 4. Stainless-steel Cylinders for Combustion Starters are Turned and Bored in Carbo-Lathes, Prior to Polishing Externally and Honing



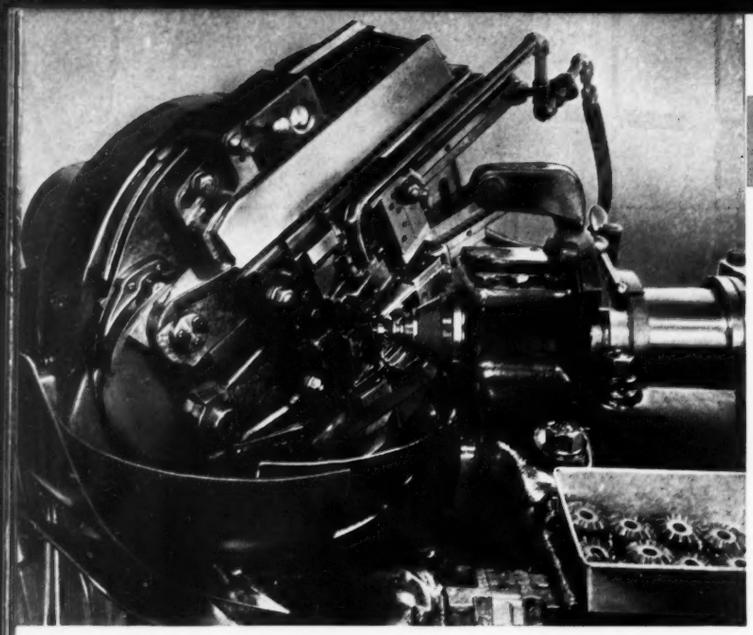


Fig. 5. Bevel Gears are Rough- and Finish-cut in This Gleason Machine with a Normalizing Process between Operations

Lathes are equipped with instruments that automatically stop them when electrically overloaded.

Small bevel gears with twenty-four teeth, 8 diametral pitch are rough-cut in the 12-inch Gleason machine shown in Fig. 5, then normalized, and finally returned to the same machine for finish-cutting. Fellows gear shapers are used for many spur-gear and spline-cutting operations, and for machining combustion-starter clutches, as illustrated in Fig. 6. The clutch teeth are held to a depth of 0.218 inch within plus 0.000 inch minus 0.005 inch. The spacing is considerably more important because it must be such as to insure uniform loading of all teeth when the clutch is engaged. This part is a chromium-vanadium-steel forging. The teeth are cut with the work revolving at a slow rate in order to generate a helical surface that obviates a triangular land on the tops of the teeth.

The combustion-starter sleeve on which splines are hobbed by a Barber-Colman machine, as seen in Fig. 7, is of unusual interest because balls that will later be assembled in these splines will also engage similar internal splines of a thrust sleeve. In addition, the starter sleeve has helical splines broached on the inside which correspond with similar grooves on a screw shaft. Balls are also assembled between the internal grooves of the sleeve and external grooves of the screw shaft.

All of the splines in the three parts mentioned are cut to a radius of 0.094 inch either by hobbing or broaching, depending upon whether they are external or internal. After the rough cuts have been taken, the parts are normalized and then the grooves are finished in the same machines. They are next lapped to size within plus 0.0005 inch minus 0.0000 inch by the machine illustrated in Fig. 9. The balls used in the grooves must measure 0.1875 inch diameter within plus or minus 0.000025 inch. The great accuracy required in these parts is necessary to insure uniform loading on all parts.

It will be obvious from Fig. 9 that the left-hand spindle is used for lapping the straight internal splines of the thrust sleeve; the next spindle is used for lapping the internal helical grooves of the

Fig. 6. Teeth of Starter Clutches are Cut in a Fellows Gear Shaper within Close Depth and Spacing Limits

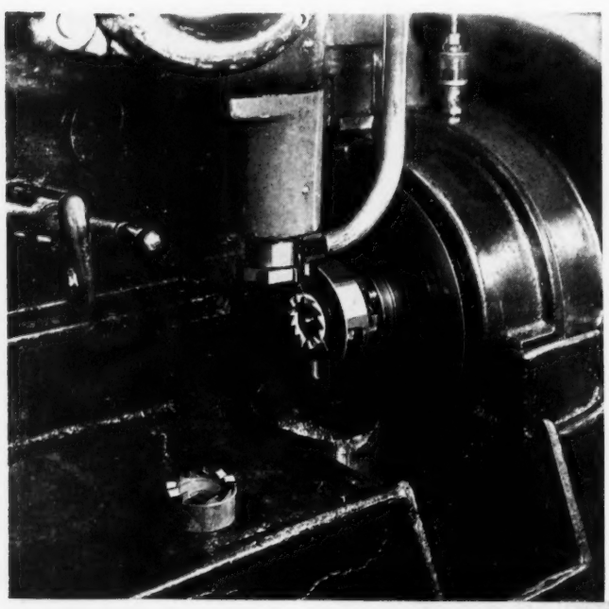
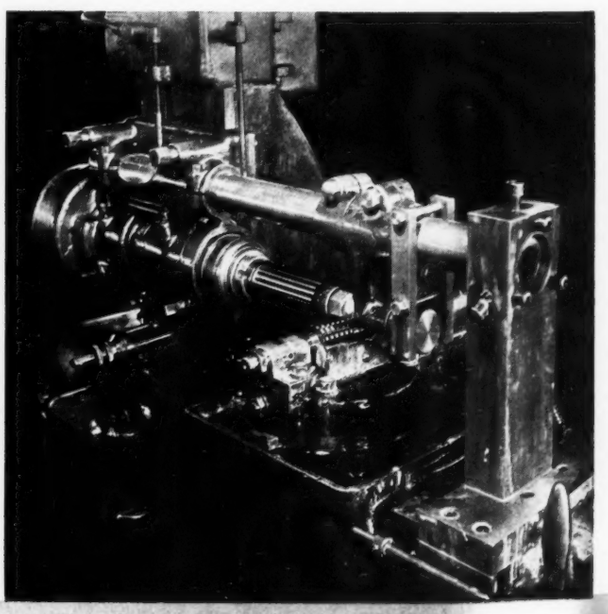


Fig. 7. Hobbing External Grooves in a Barber-Colman Machine on an Important Airplane Starter Part



starter sleeve; the third spindle is used for lapping the straight external splines of the starter sleeve; and the fourth spindle, the external helical grooves of the screw shaft. The machine used for broaching the helical internal splines in the starter sleeve is equipped with gears which revolve the sleeve in synchronism with the longitudinal movement of the broach in order to obtain splines with a helical angle of 45 degrees.

Another operation of extreme accuracy consists of precision-boring two holes in line in starter housings, such an operation being performed in the Ex-Cell-O precision-boring machine illustrated in Fig. 8. These housings are made from magnesium with nickel-chromium-steel liners. The holes are held to the specified diameter within plus 0.0003 inch minus 0.0000 inch, and must be in line within the same tolerance.

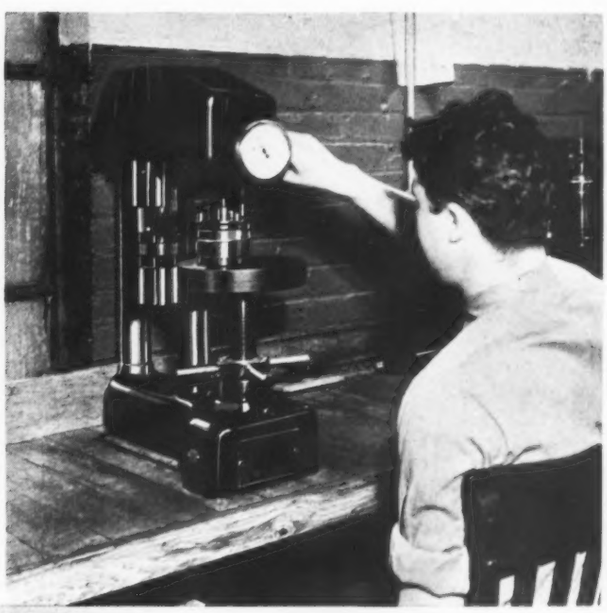
In this operation, the work is fed toward the right-hand spindle for boring the one hole and then toward the left-hand spindle for finishing the second hole. The part is firmly supported on a machined cylindrical surface. A tungsten-carbide tool is used in machining the magnesium housings, and a tantalum-carbide tool in boring the steel liners.

Rockwell hardness testers are used in various departments to insure that all work is in accordance with the heat-treatment specifications. Approximately 80 per cent of all parts are hardened, and they are inspected 100 per cent. The standard tolerance is plus 2, minus 2 on the Rockwell C scale.

Fig. 8. Holes are Bored in Starter Housings in Line and Accurate as to Diameter within a Tolerance of 0.0003 Inch

Fig. 9. Lapping External and Internal Grooves in Three Starter Parts to a High Degree of Accuracy

Fig. 10. Eighty Per Cent of the Work is Hardened and Checked for Hardness in Rockwell Machines



Airplane Riveting Operations

RIVETING became one of the most important operations in aircraft manufacture with the development of the all-metal plane —approximately one million rivets are driven in building one of the huge flying boats that are soon to operate across the Atlantic and Pacific Oceans. On an all-metal airplane, the wings, for example, may be constructed of stamped duralumin ribs joined together by rivets and covered with sheet aluminum alloy that is also attached to the ribs by rivets. Fuselages, rudders, stabilizers, and other structural sections are also generally of riveted construction. Riveting operations on this class of work differ from ordinary practice, because of the extensive use of aluminum alloys for structural members, covering, and rivets. In riveting the thin sheets, precautions must be taken to avoid distorting the material.

Riveting in another branch of the aircraft industry—engine building—is illustrated in Fig. 1. The operation here shown consists of riveting a counterweight to a crankshaft by employing a riveting hammer built by the High Speed Hammer Co., Inc., Rochester, N. Y. Four 3/4-inch steel flathead rivets are used. This operation must be as nearly perfect as possible, since human life is at stake in the failure of a mechanical part on an airplane. The rivets must not only fill the countersinks completely on both ends, but the body of the rivet must fit the hole proper tightly.

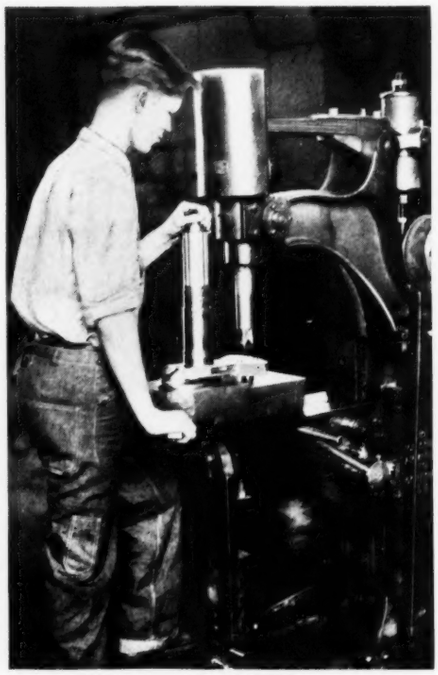


Fig. 1. (Above) Driving Flathead Rivets with a "High Speed" Hammer in Attaching the Counterweight to an Engine Crankshaft

The riveting hammer is equipped with a fixture having a hand-operated eccentric for moving the crankshaft radially, in order to successively locate the four slightly protruding rivet-heads on the anvil under the four-prong peen. The actual riveting time is four seconds per rivet.

High Speed hammers are also used for other riveting operations on airplane parts and for operations other than riveting, as, for example, to flange oil-line tubing, "dimple" duralumin sheets, hammer welded seams, and form odd shapes for experimental work.

Squeeze riveting is employed widely in airplane manufacture. By this method rivets are headed with one stroke of the riveting machine, at uniform pressure and without vibration. Fig. 2 shows a Chicago Pneumatic portable squeezer being employed at the Vultee Aircraft Division of the Aviation Mfg. Corporation, Downey, Calif., for a riveting operation on a large stabilizer.

Duralumin rivets must be driven cold immediately after heat-treatment to avoid aging of the rivets to a point where it would be impossible to drive them. Such aging occurs when duralumin rivets are exposed to room temperature for longer than three-quarters of an hour.

Fig. 2. (Left) Employing a Chicago Pneumatic Portable Squeezer in a Riveting Operation on a Large Airplane Stabilizer

Appreciation . . .

MACHINERY takes this means of expressing its sincere thanks to the concerns listed here. By extending the courtesies of their shops and the whole-hearted cooperation of their staffs they contributed greatly in making the Aircraft Number of MACHINERY a noteworthy addition to the fund of modern engineering knowledge.

Aero Supply Mfg. Co., Corry, Pa.

Air Associates, Inc., Garden City, N. Y.

Beech Aircraft Corp., Wichita, Kansas

Bethlehem Steel Co., Inc., Bethlehem, Pa.

Boeing Aircraft Co., Seattle, Wash.

Canton Drop Forging & Mfg. Co., Canton, Ohio

Chance Vought Aircraft Div., United Aircraft Corp., E. Hartford, Conn.

Consolidated Aircraft Corp., San Diego, Cal.

Continental Motors Corp., Detroit, Mich.

Curtiss Aeroplane Div., Curtiss-Wright Corp., Buffalo, N. Y.

Curtiss Propeller Div., Curtiss-Wright Corp., Buffalo, N. Y.

Douglas Aircraft Co., Inc., Santa Monica, Cal.

Eastern Air Lines, New York, N. Y.

Eclipse Aviation Corp., E. Orange, N. J.

Ex-Cell-O Corp., Detroit, Mich.

Grumman Aircraft Engineering Co., Farmingdale, N. Y.

Hamilton Standard Propeller Div., United Aircraft Corp., E. Hartford, Conn.

Jacobs Aircraft Engine Co., Pottstown, Pa.

Link Aviation Devices, Inc., Binghamton, N.Y.

Lockheed Aircraft Corp., Burbank, Cal.

McCauley Aviation Corp., Dayton, Ohio

The Glenn L. Martin Co., Baltimore, Md.

National Acme Co., Cleveland, Ohio

North American Aviation, Inglewood, Cal.

Pan-American Airways, New York, N. Y.

Pioneer Instrument Co., Brooklyn, N. Y.

Pratt & Whitney Div., United Aircraft Corp., E. Hartford, Conn.

Seversky Aircraft Corp., Bethpage, N. Y.

Sperry Gyroscope Corp., Brooklyn, N. Y.

The Stearman Aircraft Co., Wichita, Kansas

Taylor-Young Airplane Co., Alliance, Ohio

Transcontinental Western Air, Inc., New York, N. Y.

United Air Lines, Chicago, Ill.

Vultee Aircraft, Downey, Cal.

J. H. Williams & Co., Buffalo, N. Y.

Wright Aeronautical Corp., Paterson, N. J.

Routing Sheet-Metal Airplane Parts

THE cutting of sheet metal to a large variety of shapes is an important requirement in the manufacture of airplanes. This will be apparent from Fig. 1, which shows 350 fuselage details of thirty-five different shapes, used in the construction of planes at North American Aviation, Inc., Inglewood, Calif. These details were cut to the required shape from large sheets of duralumin by employing an Onsrud heavy-duty portable router as illustrated in Fig. 2.

Ten sheets of duralumin 4 feet wide by 12 feet long by 0.040 inch thick are stacked on top of each other for cutting through the entire ten sheets at one time. Wooden templets of the same outline as the desired shapes are then fastened on top of the sheets for guiding the router in the manner illustrated. All of the pieces shown in Fig. 1, for example, were produced by guiding a router around thirty-five templets clamped on top of ten sheets of material. By careful arrangement of the templets, the waste material is held to only about 9 per cent in such operations.

Smooth edges are obtained by this method, the router being driven at high speed by a pneumatic turbine. On one Onsrud heavy-duty router, the speed is 22,000 revolutions per minute and on another model, 30,000 revolutions per minute. A governor automatically adjusts the air consumption in accordance with the load.

Hand routers manufactured by the same concern are also applicable in airplane manufacturing plants. In Fig. 3 one of these routers is shown in use at Vultee Aircraft, Division of the Aviation Mfg. Corporation, Downey, Calif. This operation consists of profiling the edges of a sheet-metal part that has been blanked and formed in presses. Hand routers are also employed in the Vultee plant for simultaneously cutting stacked aluminum-alloy sheets into fuselage details. Inside and outside contours can be readily cut. Onsrud hand routers are operated at a speed of 50,000 revolutions per minute.

Fig. 2. The Router is Guided Over the Stack of Sheets by Means of Wooden Templets

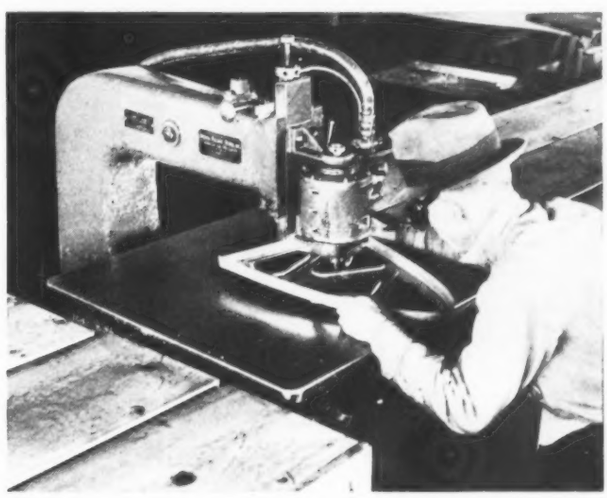


Fig. 3. Finishing the Edges of Irregular Openings in an Airplane Sheet-metal Part by Employing an Onsrud Router

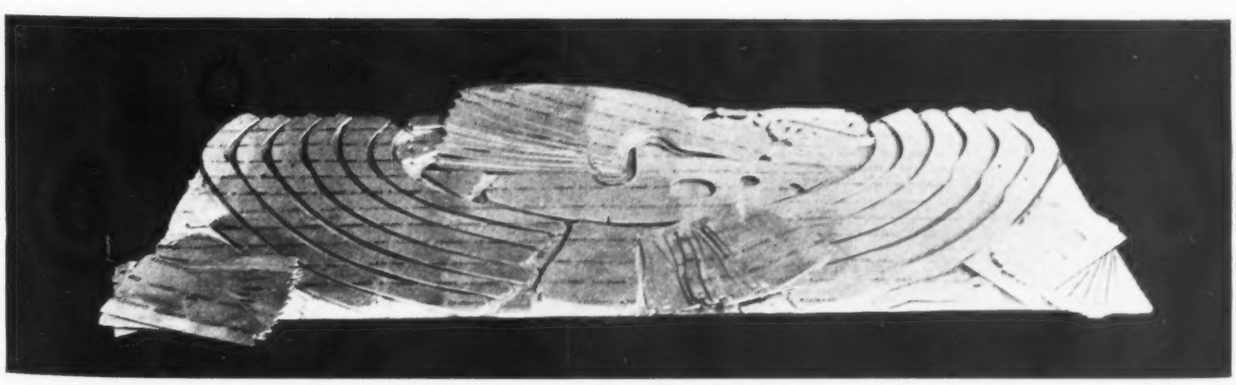


Fig. 1. Thirty-five Different Shapes are Routed, Ten at a Time, from Stacked Sheets of Duralumin

Drilling and Reaming Operations

Three Special Machines Designed to Meet Machining Problems of the Aircraft Industry, in which

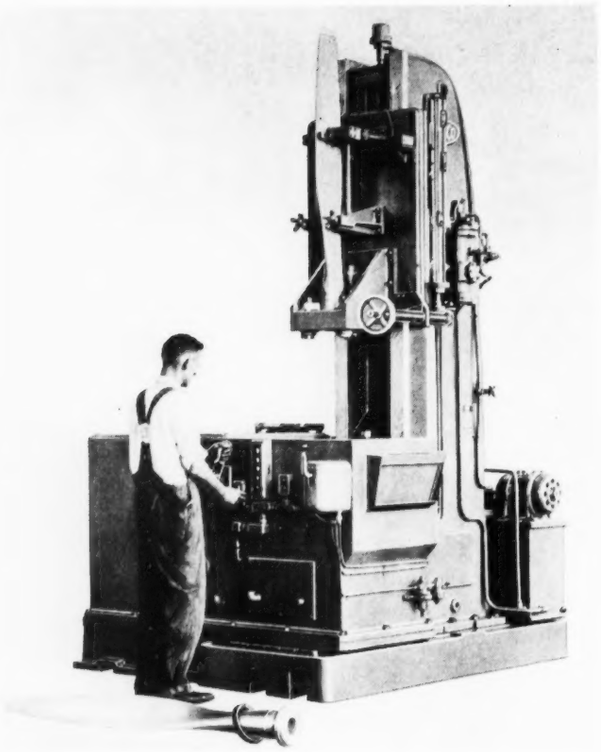


Fig. 1. Natco Deep-hole Drilling Machine which Roughs and Finishes a Long Tapered Hole in the Hub End of Propeller Blades

PRODUCTION in the aircraft industry has attained sufficiently high levels to warrant the use in numerous instances of machines designed for single-purpose applications. This article will describe several machines of that classification which have been built by the National Automatic Tool Co., Richmond, Ind., for use in the manufacture of propeller and engine parts in airplane plants.

A vertical deep-hole drilling machine used for drilling and reaming a tapered hole 16 1/2 inches long in the hub end of aluminum-alloy propeller blades, is illustrated in Fig. 1. Four operations are performed in roughing and finishing this hole through the use of four different tools in the sequence indicated in Fig. 2. The work is mounted on a slide above the revolving tool and fed to the tool under hydraulic pressure. The slide is also traversed to and from the work by hydraulic means.

The first operation consists of taper drilling with the special tool seen at the left in Fig. 2 and also in the cutter spindle of the machine shown in Fig. 3. This operation is performed to a depth of 13 inches. At the end of this cut the operator mounts the second tool on the tool spindle for taper drilling to the full depth of 16 1/2 inches. The hole is next rough-reamed with a special tapered reamer, and finally finish-reamed with the tapered reamer seen at the extreme right in Fig. 2. In all four operations, cutting lubricant is forced to the cutting edges of the tool through an oil-hole that extends the full length of the tool in the center. The cutting lubricant is delivered to the tool itself through the hollow cutter spindle.

The operation of the machine is controlled by means of an automatic time delay reverse, positive stop, feed valve and three sets of stop dogs. The

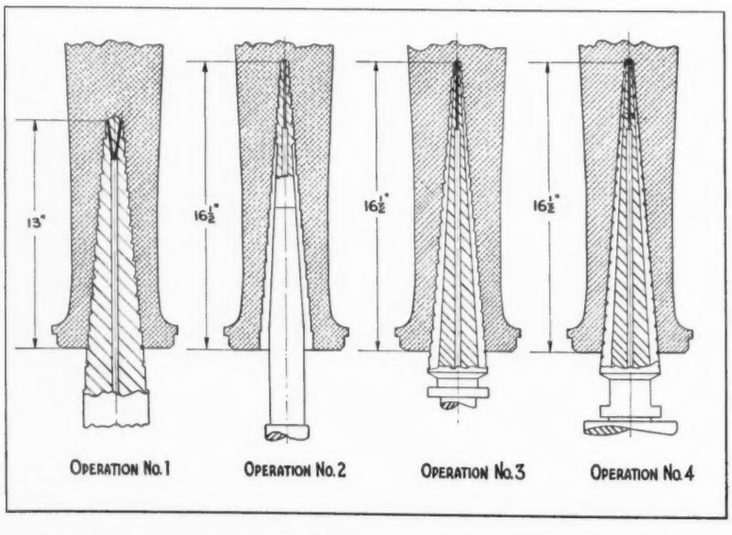


Fig. 2. The Sequence of the Operations Performed by the Machine in Fig. 1 in Taper Drilling and Reaming a Long Hole in the Hub End of Propeller Blades

on Propeller and Engine Parts

Production Requirements are Now High Enough to Warrant Using Single-Purpose Equipment

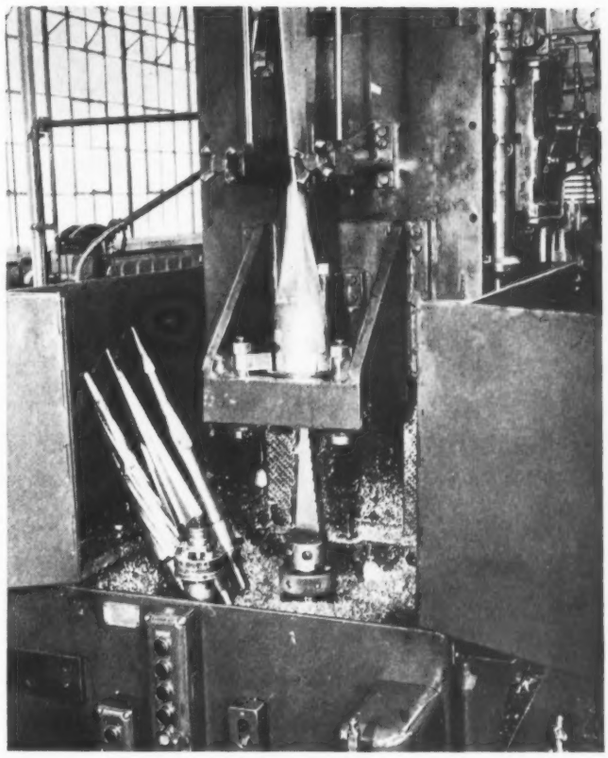


Fig. 3. Close-up View of the Machine and Tools Used in Taper Drilling and Reaming Airplane Propeller Blades

latter are manually placed in the operating positions to automatically control the lengths of the head travel. Spindle speeds can be changed to suit the particular tool being used by shifting a lever that is conveniently located at the front of the machine.

After the operator has loaded a propeller blade in the fixture of the traversing slide and placed the tool in the spindle, he starts the machine. The work-slide then rapidly traverses downward to the machining point, feeds to the correct depth, rapidly returns to the starting position, and stops. The operator then changes the tool and shifts the dogs which control the travel distance of the slide. This cycle is repeated until all four tools have been used and the operation finished.

The horizontal two-way machine illustrated in Fig. 4 was built for drilling nineteen holes around the hub cams of airplane propellers, as shown in Fig. 5. This machine was constructed of two Natco Holesteel floor type units, each equipped with a single-spindle head. In addition there is an indexing fixture that is arranged for holding either one of two types of hub cams. These cams are made of steel.

The fixture may be located in ten radial positions and in three different positions along the horizontal axis. By indexing the work as required and changing the tools to suit the different sizes of holes, both types of hub cams can be completely drilled in two set-ups. In addition, three of the drilled holes are reamed.

In the first set-up, eight "cam track end" holes are drilled two at a time with a 90 degree indexing of the work between each drilling. Then the work is unloaded, the index drum is changed and the work reloaded. Eleven weight-reducing holes are then drilled, ten of them two at a time and with an indexing of the work between each drilling step. For drilling the eleventh hole, one drill is removed. In the next to the last step of the operation, one hole is reamed and in the last step, two holes are reamed.

Sixteen different operations are performed on aluminum-alloy cylinder heads by the machine shown in Fig. 6, which is constructed from a Holesteel floor type unit and a two-position hand indexed fixture mounted on a steel base. The opera-

Fig. 4. Machine Used in Drilling Nineteen Holes Around Large Steel Hub Cams that are Used in Airplane Propeller Units

Fig. 5. (Above) Two of the Hub Cams Drilled and Reamed in the Machine Shown in Fig. 4

tions consist of rough- and finish-machining the valve seats and valve-guide holes. The fixture is located in one position for completely machining one valve seat and its guide hole and is then indexed into the second position for finishing the second valve seat and guide hole. One operator loads the machine, changes the tools as required, and indexes the fixture. The production of this single-head machine ranges from eight to ten cylinder heads an hour.

With the fixture in the first position, the operations are performed in the sequence illustrated diagrammatically in Fig. 7. First, the valve-seat hole is bored with a multiple-blade end cutting tool. The second operation consists of spot-drilling for the valve-guide hole and at the same time rough-counterboring the valve seat. The third operation consists of drilling the valve-guide hole. In the fourth operation the valve-guide hole is line bored in relation to the valve seat and the valve seat is

Fig. 6. (Right) Precision Boring Machine Designed for Finishing the Valve Seats and Valve-guide Holes in Aluminum-alloy Cylinder Heads for Airplane Engines

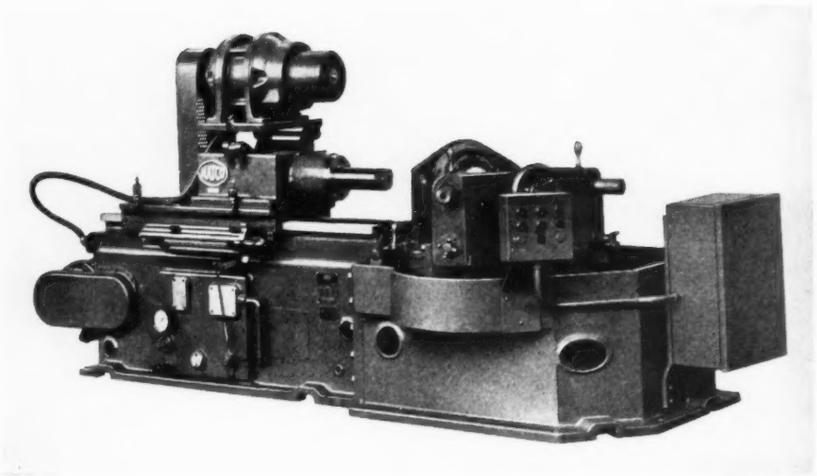
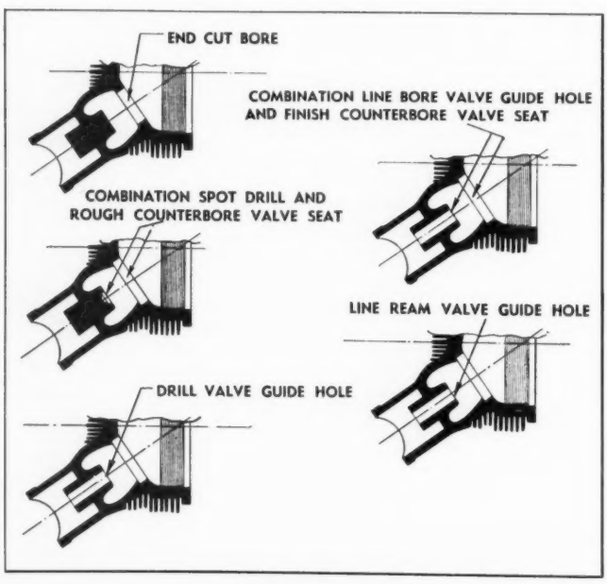


Fig. 7. (Below) Diagrams which Illustrate the Sequence of the Operations Performed by the Machine in Fig. 6


END CUT BORE
COMBINATION LINE BORE VALVE GUIDE HOLE AND FINISH COUNTERBORE VALVE SEAT
COMBINATION SPOT DRILL AND ROUGH COUNTERBORE VALVE SEAT
LINE REAM VALVE GUIDE HOLE
DRILL VALVE GUIDE HOLE

finish-counterbored, both cuts being taken by a combination tool. The final operation consists of line reaming the valve-guide hole. Upon the completion of these operations the work is indexed for performing nine similar operations on the second valve seat and valve-guide hole of the same cylinder head.

* * *

New Chapters of the American Society of Tool Engineers

The American Society of Tool Engineers has recently added three new chapters, bringing the total number up to twenty-one. The latest chapters added are those in Syracuse, N. Y., Schenectady, N. Y., and Cincinnati, Ohio.

The continued growth of the Society has made it necessary to move the headquarters, which are located in Detroit, to 2567 W. Grand Blvd., where the Society will have ample space for continued growth and where appropriate offices and meeting rooms are provided for the officers and committees.

Federation of Labor Offers Cooperation to Industry

THE statement recently made by the Executive Council of the American Federation of Labor, during the annual meeting of the Chamber of Commerce of the United States, is one of the most significant declarations of labor leadership for decades, and may herald an era of cooperation instead of strife. Some of the important points brought out by this statement are as follows:

"Unemployment can only be overcome through the creation of work opportunities for working men and women in private industry. This is the real remedy for unemployment. The time has arrived when, through cooperation, understanding, and a proper regard for the rights of all employers and employes, industry and labor should get together and seek to find a way by which this real remedy for idleness can be applied.

"The American Federation of Labor is committed to the principle of private ownership, private initiative, and the protection of private property. The right to own and manage property must be conceded and safeguarded. Working people must be accorded the right to organize and bargain collectively. The highest wages which industry can afford should be paid, and a fair return upon legitimate investments to those who own private property must be freely conceded."

It is further emphasized that labor and capital can cooperate and can develop efficiency and production through labor organizations sponsored by the workers, and through industrial organizations sponsored by management. Through the establishment of contractual relationships, industrial peace can be promoted and industrial production stabilized. Contracts entered into between organized labor and industrial management must be regarded as obligations that under no circumstances can be violated. Organizations of labor should be governed by democratic policies, rules, and procedure. This is the American way.

In conclusion the statement says, "Through the development of team-work between industry and labor, many economic wrongs can be righted, many of industry's legislative burdens can be remedied, and the maximum service which industry and labor may render can be given the entire nation."

When labor leaders take this attitude, it is an invitation to cooperation rather than strife; and through such cooperation, if sincerely entered into by both sides, a new era in the economic life of this nation is possible. What is required is that all concerned respect and recognize the economic and legal rights of both employe and employer, for the welfare and best interests of both.

Standardization of Taps with Cut and Ground Threads

A proposed revision of the American Standard for Taps, originally published in 1930, has recently been completed by the committee of the American Society of Mechanical Engineers having this work in hand. This revision includes a number of additional types and sizes, and contains more definite specifications for marking, as well as terminology and definitions for taps. The proposed revision is now being distributed to industry for criticism and comment. Copies may be obtained by application to C. B. LePage, assistant secretary, American Society of Mechanical Engineers, 29 W. 39th St., New York City.

* * *

Engineering College Cooperates with Industry

The New York University College of Engineering has inaugurated a new method of cooperation with industrial leaders. In an effort to better coordinate the college curricula and the requirements of industry, Dean Saville of the College has asked more than forty industrial leaders and public officials to meet faculty members and alumni representatives in a series of round-table discussions pertaining to engineering education. W. A. Hoffman, engineer of methods and standards of the Bridgeport Brass Co., R. E. W. Harrison, vice-president and general manager of the Chambersburg Engineering Corporation, and Richard Dickenson, chief engineer of the Mining Division of the Ingersoll-Rand Mfg. Co., were among those attending the first conference.

* * *

Old Employes Honored

On May 23, the Farrel-Birmingham Co., Inc., Ansonia, Conn., held its second annual service banquet, with 130 men who have been with the company for twenty-five years or more as guests of honor. Nine of these, who have served the company for fifty years or more, were seated at the head table. Twelve men, who this year joined the ranks of the 148 employes having a service record of over twenty-five years, were presented with the company's Service Pin. John D. Martin, having just completed fifty years of service, received a gold watch and chain. The chief speaker was Louis M. Ruthenburg, president of Servel, Inc., who paid tribute to the veteran employes, and to their American ideals and traditions.

EDITORIAL COMMENT

Aviation has gradually arrived at the point where it is taking a definite and assured place among the world's means of transportation. The number of plants engaged in the manufacture of aircraft, engines, and auxiliary equipment is increasing year by year in this country and abroad. The amount of manufacturing equipment used in these plants and the number of men employed are rapidly reaching a point that will place the aircraft industry among the major manufacturing industries. Last year, the production of the aircraft and allied industries in the United States exceeded the $100,000,000 mark; during the present year, this figure will be materially increased.

Aviation Progress Has Built a New Major Industry

Engines of 1500 horsepower are now being built for airplanes. Engines of 2000 horsepower are likely to be produced in the near future, at least one model having reached the endurance test state during the past year. Planes that will make regular transatlantic travel a possibility are being completed, and before the end of the year we may see New York and London tied together by planes that will cover the distance between the two cities in twenty-four hours or less, traveling on regular flying schedules.

Progress in the building of smaller planes has been equally marked. There has been a thorough study of the possibilities of engines of 100 horsepower and less, and several manufacturers specialize on such engines with a view to promoting the manufacture of low-priced airplanes for individual ownership. In the development of planes and engines, both large and small, great strides have been made toward greater simplicity of operation. It is expected that, in the newer designs, maintenance costs will be considerably reduced, the frequency of overhauling minimized, and the time required for this work decreased.

Improved safety features have greatly added to the practicability of air transportation as an accepted means of travel. Apart from scores of instruments that have been designed, each adding to the safety of operation, one of the most spectacular recent developments is that of automatic landing installations. This development will doubtless have the most profound influence on commercial aviation. In experiments that have been conducted, scores and scores of landings have been made without a human hand touching the controls. There is evidence to support the belief that with the automatic landing system, airplanes can be safely landed in the densest fog.

The tremendous development that has taken place in the field of aircraft and the great manufacturing organizations that have grown up as a result obviously have had a tremendous effect in stimulating demand for precision manufacturing equipment. A great many machine tool building plants and tool manufacturing shops have contributed to the success of the aircraft industry by the production of high-class equipment. In the future, the demand for such equipment will be even greater.

Most Remarkable Developments Now under Way

During the last few years, taxes—Federal, state, and local—have increased so rapidly as to stifle industry and put a brake on enterprise and employment. A specific example of how the tax burden has increased since 1934 is furnished by the experience of one of the largest electrical manufacturing companies in the country.

Taxes that Stifle Industry Hurt the Worker Too

The tax bill of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., was $14,046,475 in direct taxes during 1937, or nearly $300 for every worker employed. These taxes compare with $2,511,000 in 1934, $4,987,000 in 1935, and $8,946,753 in 1936. The 1937 taxes were equivalent to a tax of $54,263 every working day. If to this are added the direct and hidden taxes paid by the employe from his income, all of which must be paid by the work of the individual, we find that close to $35,000,000 in taxes is being paid by the Westinghouse company and its employes. Every worker must produce enough work to pay $700 in taxes annually before there is anything for himself or the company.

Taxes come first. They cannot be side-stepped. As yet, the American people are not tax-conscious, because the worker's contribution is hidden by clever politicians, who tell him that all the taxes are paid by the rich. What did Lincoln say about not being able to fool all of the people all of the time? Let us hope he was right.

Ingenious Mechanical Movements

Mechanisms Selected by Experienced Machine Designers as Typical Examples Applicable in the Construction of Automatic Machines and Other Devices

Ratchet Mechanism with Special Pawl Arrangement

By PAUL GRODZINSKI

A ratchet mechanism with rather an unusual pawl arrangement is shown with the operating lever in three different positions in the accompanying illustration. This ratchet mechanism is used to rotate a rope drum employed to provide the tension required for joining conveyor bands or belts. It can also be utilized as a conveying device for heavy machines and for other purposes.

The ratchet wheel *A* is directly connected with the rope pulley or drum. The operating lever *B* supports a ratchet pawl *C* which produces only a forward motion of the ratchet wheel. Any reverse motion is prevented by another pawl *D*, fixed in the base of the mechanism and pressed against the ratchet teeth by a spring. Operating lever *B* causes rotation of the wheel and the rope drum.

When the winding work is completed, the hand-lever is brought into the position shown in Fig. 2, where it is stopped by a pin which comes in contact with lever *E*. Pawl *D* remains in mesh with the ratchet teeth, so that any unintentional motion of the wheel is prevented should pawl *C* be accidentally disengaged. If it is desired to withdraw the rope, the hand-lever is placed in such a position that the fixed pin lies in front of lever *E* and causes it to tilt, as shown in Fig. 3. In this position, the cam-like surfaces of the pawls disengage the pawls from contact with the ratchet teeth. This device was developed by P. Wever, Düsseldorf, Germany.

Mechanism for Regulating the Movement or Pressure Applied to a Rod

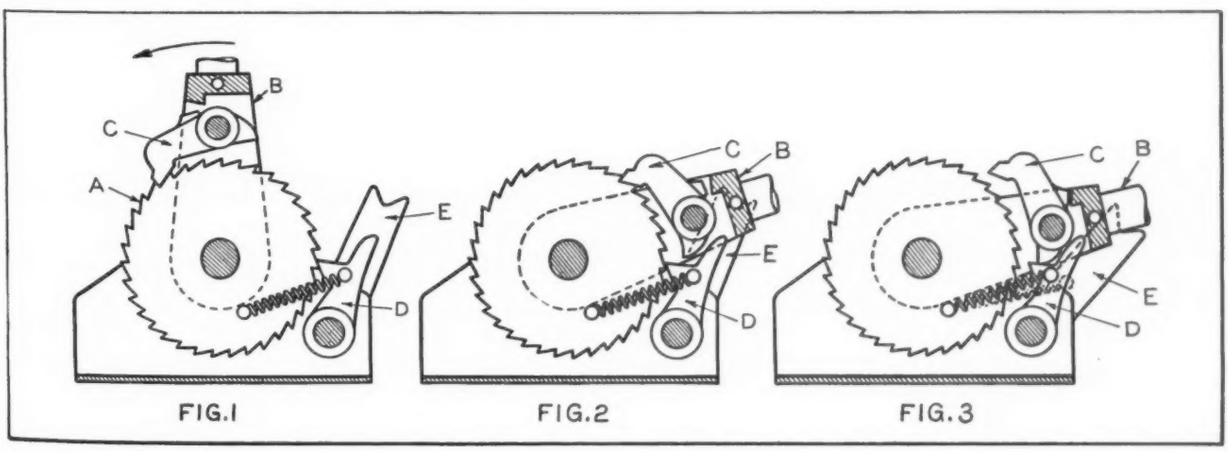
By F. H. MAYOH

The device shown in the accompanying illustration is designed to provide adjustable control over the travel or pressure applied to rod *A*. The normal actuating movement is obtained by having the end *B* of plunger *C* rock to a position B_1, there being a spring return (not shown) for rod *A* which keeps it back in a position to make contact with the end *B* of the actuating plunger.

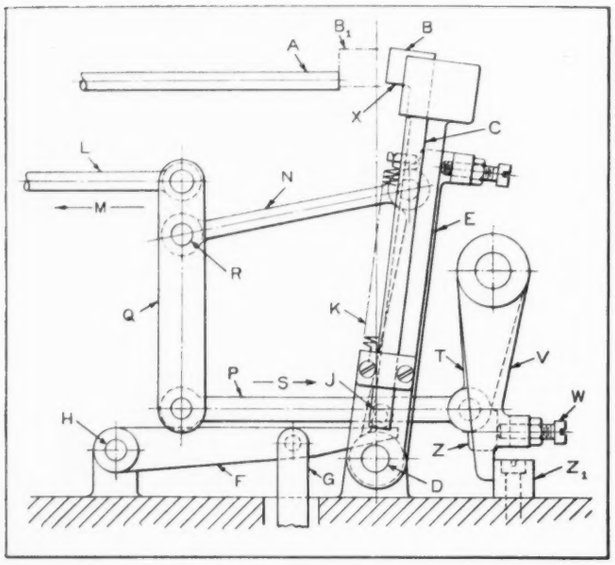
Plunger *C* is supported indirectly on a stud *D* that also carries a swinging block *E*, in which the plunger is free to slide up or down as required. The upward motion is obtained by raising the lever *F* through the medium of the link *G* operated from within the machine. Lever *F* pivots about the holding pin *H* and makes contact with a roll *J* attached to plunger *C*. There is a tension spring at *K* which holds the plunger *C* down against the lever *F*.

When lever *F* raises plunger *C*, the entire swinging unit will rock back and forth without permitting the end *B* to strike rod *A*, as that portion *X* on the plunger will pass over the top of the rod. There is an ingenious arrangement for swinging the arm *E* back and forth, which is provided with means for adjustably controlling the travel from the right side of the mechanism, where the adjusting means is accessible to the operator of the machine.

Movement imparted to the connecting-rod *L* from within the machine in the direction of the



Lever-operated Ratchet Mechanism with Special Pawl Arrangement



Mechanism for Controlling Movement Imparted to Rod A by the End B of the Oscillating Plunger C

arrow *M* pulls rod *N* in the same direction until the end *B* of the plunger meets resistance by coming against rod *A*, the fulcrum point for lever *Q* being about *R* as a movable center. This throws the thrust of link *P* in the direction indicated by arrow *S*, where it is carried to the lever *T*, which has an end *Z* that makes contact with an adjusting screw *W* in an adjacent lever *V*. Lever *V* makes contact with the block Z_1 attached to the machine bed. By adjusting screw *W*, the relationship between the two levers *T* and *V* is changed, thereby controlling within a limited range the striking action of *B* against rod *A*.

Pivotal Joints for Special Purposes

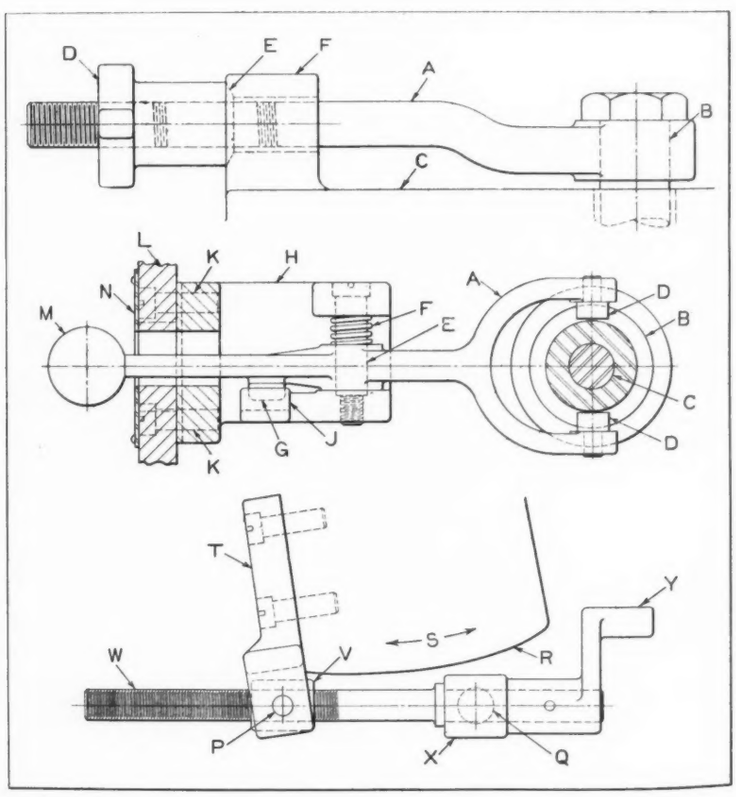
Pivoting joints of three different designs developed to meet special requirements are shown in the accompanying illustration. These joints are used to maintain proper alignment or free action of certain members. In the design shown in the upper view, the adjusting screw *A* pivots on the stud *B* which is attached to a swivel slide within the machine, a portion of which is indicated at *C*.

The knob at *D* has a curved surface at *E* which fits a mating surface in the lug *F*. As the knob is moved along the threaded portion of the screw, the end of the screw at *B* swings forward and back through a radial arc, the radial seat at *E* permitting the knob *D* to adapt itself to this swinging motion, which is in a horizontal plane at right angles to the center line of screw *B*.

In the central view of the illustration is shown a fork *A* used for shifting a clutch *B* on shaft *C* through the medium of the two pins *D*. This shifting fork pivots on the screw *E*. A spring at *F* holds the shifting lever in contact with one side of the bearing, thus preventing it from vibrating. There is also a stop-lug at *G* which limits the sidewise movement of the lever by coming in contact with the side of lug *J*. This entire lever construction is attached to a bracket *H*, secured by screws at *K* to the front of the machine, a portion of which is shown at *L*. The shifting lever is operated by a round knob at *M*. A plate *N* is fastened over an elongated hole through which the unit is assembled.

Two pivot pins are incorporated in the arrangement shown by the lower view, which is employed for moving a swivel plate *R*. The pivot points are indicated at *P* and *Q*. Plate *R* is adjustable about a stud (not shown) with a circular oscillating movement indicated by the arrow *S*. On the side of plate *R* is mounted a block *T*. In a slot in the lower end of block *T* is carried a block *V* which is pivoted on two short pins *P*. Block *V* is tapped to receive the screw *W*.

The pivot point at *Q* consists of a turned stem which forms part of the bearing *X* in which the screw *W* revolves when turned by the hand-lever *Y*, pinned to the shaft. The stem *Q* is free to revolve in a fixed base. Plate *R*, in traveling back and forth as indicated by arrow *S*, causes screw *W* to assume various angles, the swivel mountings permitting it to pivot at points *P* and *Q*. H. M.



Three Types of Pivotal Joints Designed for Special Purposes

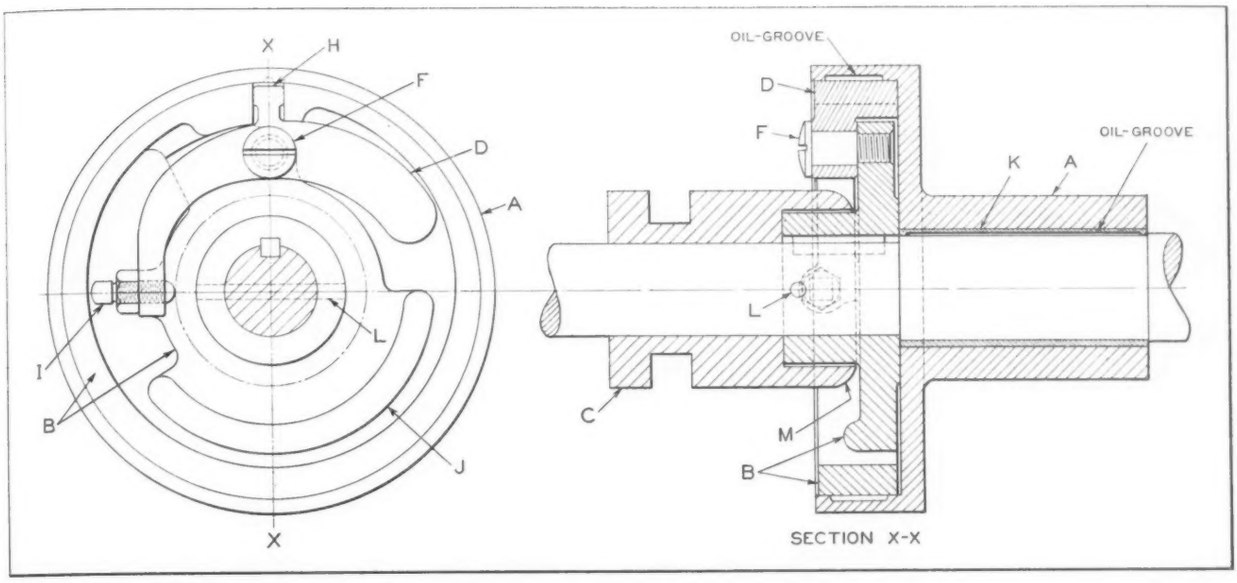


Fig. 1. Friction Clutch Designed for Use at High Speeds

Friction Clutch for Grinding Machines Operated at High Speeds

By J. R. WHITTLES

In Fig. 1 is shown a friction clutch that can be nicely balanced to permit operation at high speeds without perceptible vibration. The writer does not offer this as a new design, since a similar clutch was used years ago on a commercial machine; but as the design has apparently never been described in the technical press, the description which is given in this article may be of interest to MACHINERY'S readers.

The various parts of the clutch, shown in Fig. 2, are balanced separately and as a unit. The body *A*, Fig. 1, is made of semi-steel and finished all over. It has a bushing *K* and runs free when not engaged with the expanding ring *B*. The expanding ring is also made of semi-steel and is so shaped that it will balance itself. The raised portion at *J* shows the method of distributing the metal to obtain the required balance. At *C* is a hardened steel cone that slides along the shaft to operate the finger *D*. It is rounded at the front end *M* which acts as a cam when in contact with the point of the set-screw *I*. The set-screw *I* is screwed into a tapped hole in finger *D* and is locked in position by a check-nut. The round point of this screw is hardened to prevent wear.

The clutch finger *D* is a steel casting, shaped to assist in balancing the unit. It is pivoted about the screw *F*, which is threaded into and fastened to the expanding ring *B*. The lever arm *H* is a part of finger *D* and serves to expand ring *B*. Ring *B* is keyed to the shaft and is held in position by a pin *L*.

To engage the clutch, the operator simply slides the cone *C* toward the expanding finger *D*, bringing the cam face *M* into contact with the set-screw *I* and moving it outward, thus causing finger *D* to pivot about screw *F*. The lever arm *H* fitted in the slot in ring *B* causes the ring to expand and grip the inner friction surface of the clutch body *A*. The expansion of ring *B* causes the entire unit to turn as one member. Cone *C* is counterbored to fit over the hub of member *B*, so as to enable the clutch cone to operate as near the center of the clutch ring as possible. All rotating parts of the clutch are lubricated with oil.

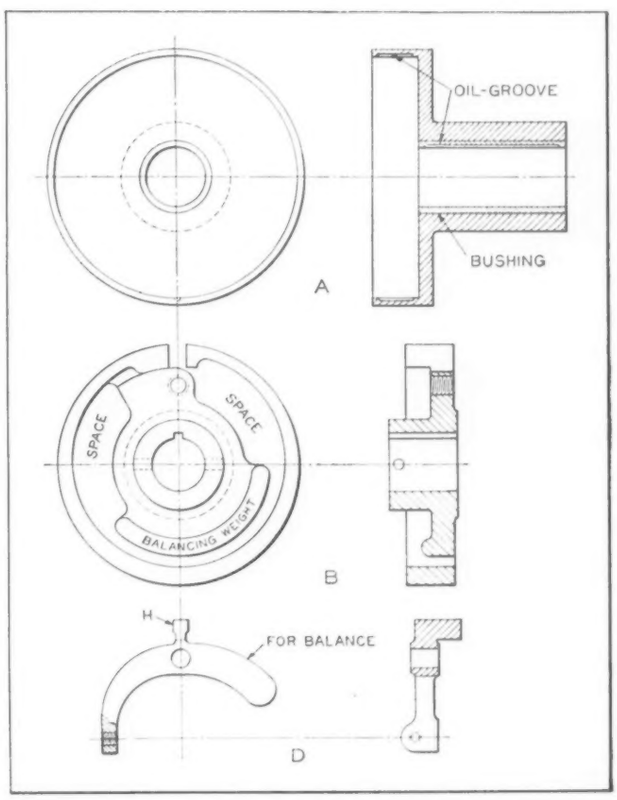


Fig. 2. Details of Parts Comprising Clutch Shown in Fig. 1

Engineering News Flashes

The World Over

Sound Waves Used for Disrupting Solid Substances

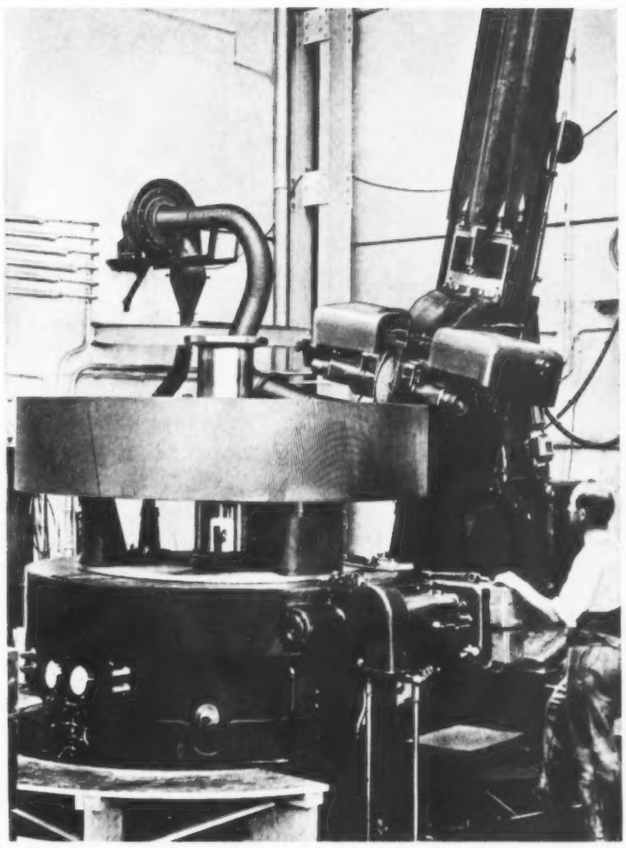
A method of preparing colloidal solutions of solid substances in liquids, permitting a much finer particle size and longer suspension than has hitherto been possible, has been developed by Dr. Karl Söllner of Cornell University. A patent on the process has been applied for, which is assigned to the Acheson Colloids Corporation of Port Huron, Mich. The invention is based upon the observation that solid particles of a certain form or structure can be disrupted by sound waves, including so-called "ultrasonic" waves. The term "ultrasonic" is used by physicists to denote sound waves which are beyond the range of audibility by the human ear. The apparatus for creating the sound waves consists essentially of a high-frequency current generator and a piezo-electric crystal of quartz. In practice, the new method will be used for the preparation of graphite, steatite, and similar substances that are suspended in liquids for lubrication purposes.

Polaroid Detects Fraudulent Eyesight Damage Claims

Polaroid, a newly developed material which polarizes light so that it vibrates in one plane only, is now being used in a device for detecting fraudulent claims for impaired eyesight. According to the American Optical Co., this new eye testing device will find extensive use in professional and insurance offices, as well as in medical departments of industrial concerns, as it will aid in detecting fraudulent and excessive claims for eye damages.

The instrument consists of a Project-O-Chart, for projecting test letters, and a single polarizing lens in front of the projector. This polarizer can be turned through a 90-degree angle, thereby changing the polarization plane to any degree desired. In front of the test subject's eyes are placed two polarized lenses with the polarization planes at right angles to each other. By turning the polarized lens in front of the projector from one point to another, the test letters become visible to the left or right eye of the test subject at the will of the examiner, although this change in visibility is unknown to the person being examined. In this manner, it can quickly be discovered whether the examined person is shamming loss of sight in either eye, since he is never aware of with which eye he is seeing. Once more physical science and engineering are aiding the medical profession.

A Drapery Woven from Glass Thread, Representing a Radical Departure in Textiles. The Drapery is Hung in Front of a Wall Constructed from Glass Bricks.—Photo, Courtesy Corning Glass Works, Corning, N. Y.



This Maag Gear-grinding Machine, Installed in the Plant of the Maag Gear Wheel Co., Ltd., Zurich, Switzerland, is the World's Largest Machine for Grinding Gears. It is Designed for Grinding Spur and Helical Gears up to 12 Feet in Diameter and 3 Feet 4 Inches Face Width. With This Machine, the Maximum Pitch Error is Guaranteed to be Less than 0.0004 Inch. Large Gears with Pitch Errors not Exceeding 0.00015 Inch have been Ground on the Machine

Industry Prepares to Make Artificial Wool

For years scientists, chemists, and engineers have been carrying on intensive research in an attempt to produce artificial wool from fibers. A new fiber, known by the trade name "Rayolana," has now been developed by the firm of Courtaulds, Ltd., in Great Britain, from which it is believed that a material having the properties and dyeing possibilities of natural wool can be made.

Progress in High-Temperature Determinations

In the annual report of the National Physical Laboratory of Great Britain, it is mentioned that remarkable progress has been made in determining, with great accuracy, temperatures in the region from 1500 to 2000 degrees F. It was not so many years ago when such high temperatures could be determined with an accuracy not closer than 10 degrees. Three years ago, an accuracy of one-fifth of a degree was possible of attainment. More recent advances in instruments and technique now enable an accuracy of one-twentieth of a degree to be attained.

World's Largest Tunnel Bore

What is claimed to be the largest section of any tunnel yet bored is that of the Yerba Buena tunnel, by which the roadway of the San Francisco-Oakland Bay Bridge makes its way through a rocky island that divides the two sections of the bridge. This tunnel is 79 feet wide, 57 feet high in the center, and 540 feet long.

Latest Achievements in Light-Weight High-Speed Trains

Light-weight, high-speed railroad equipment has now been installed for fast service between New York and Chicago. Both the New York Central and the Pennsylvania Railroads inaugurated on June 15, a sixteen-hour service between New York and Chicago, with an entirely new type of engine and train. Light-weight welded construction is used throughout the main portion of the structure of the cars, the material being high-tensile alloy steel. Aluminum alloys are used for such parts as floor supports, partitions, and interior trim. The trucks are of alloy cast steel with alloy steel springs, and equipped with roller bearings.

Unusual Post Office Mail-Conveying Equipment

An unusually complete conveyor system for handling letter mail has been installed in one of the post offices in Berlin, Germany. This equipment consists of over 7000 individual conveyor belts with a combined length of twenty-five miles. About 400 motors are used for driving these conveyor belts and connecting chain conveyors and elevators. Over 3,000,000 pieces of letter mail are handled daily. The conveying equipment is so complete that practically no transportation of mail by trucks or in baskets is required from the moment the mail enters until it leaves the building.

Diesel Engine Forges Ahead Rapidly

The rapidity with which the Diesel engine is making a place for itself as a power generator is indicated by the fact that in Germany alone the output of Diesel-engine horsepower in 1937 was six times that in 1932. The exports of Diesel engines from Germany comprised about 40 per cent of the total output, as measured in horsepower.

The Machine Tool Exhibition at the Leipzig Fair

Concluding Article of a Series

IN the articles published in May and June MACHINERY, pages 620 and 680, respectively, the trend of present German machine tool design, as exemplified by the exhibits at the recent Leipzig Fair, was indicated by illustrating a number of German machine tools of modern design. The present article will illustrate additional types of German machines, thereby giving the American machine tool designer a further idea of the trends in the German machine tool industry.

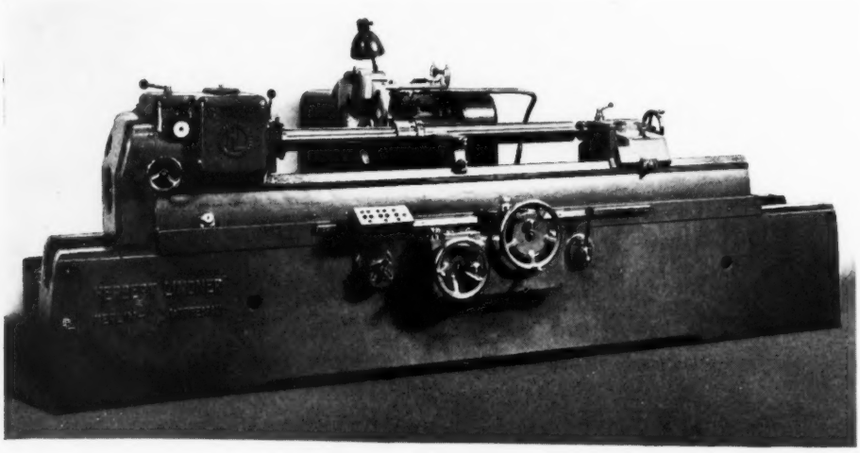
In one of the previous articles, it was pointed out that machines for thread-grinding have been highly developed. A precision thread-grinding machine built by a well-known German maker is illustrated at the bottom of this page, the size and capacity being indicated in the caption.

A thread-milling machine especially intended for milling short threads of fine pitches is shown on page 785. This machine is primarily intended for the milling of fine threads, such as used, for example, on optical instrument parts and fittings. The entire width of the threaded part on the work is milled at once, so that the thread is completed in a single revolution of the work, after which the cutter withdraws automatically and the machine stops. The thread obtains its lead by the automatic movement of the cutter relative to the work during the milling operation.

In the article in June MACHINERY, page 680, reference was made to the fact that surface-hardening with the acetylene flame has been highly developed in Germany and that many special machines for the purpose have been designed. At the top of page 784 are shown two such flame-hardening machines. The one to the left is intended for the hardening of gear teeth. It is wholly automatic in action, the movements of the flame, the water jet, and the indexing from tooth to tooth being taken care of automatically. The other machine, to the right, has been especially designed for flame-hardening locomotive guide bars, but can be applied to the flame-hardening of long flat wearing surfaces in general. The motions of this machine are also controlled automatically.

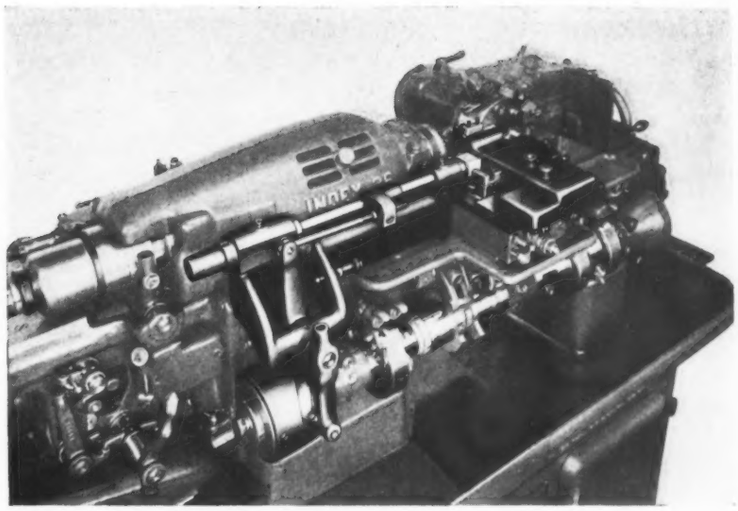
Reference was also made in one of the previous articles to the type of protecting bellows so frequently seen on German machines for preventing grinding dust, chips, dirt and grit from falling on the ways of machine tools. A good example of the application of such protecting bellows may be seen on the grinding machine illustrated at the bottom of page 783, where both ends of the bed ways, as well as the ways for the wheel-head slide on the upright, are so protected.

In concluding this series of articles on machine tools exhibited at the Leipzig Fair last March, it may well be emphasized that just as German machine tool designers closely follow developments and innovations in American machine tools, so American machine tool designers may profitably study what has been accomplished by some of the leading German machine tool builders; and there is no doubt that nowhere can this progress be more comprehensively studied than at the annual Leipzig Fair. That Fair is the show-window, so to speak, of German industry, and the latest developments and most advanced practices not only in machine tools, but in all the branches of the German mechanical industries, are certain to be exhibited to best advantage for observation there.

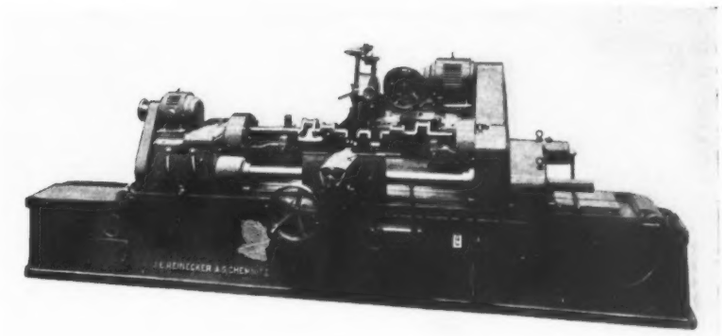


Herbert Lindner Large-capacity, Precision Thread-grinding Machine for Work up to 79 Inches Long between Centers. Threads up to 12 Inches in Diameter and 12 Inches in Length can be Ground; but by Shifting the Lead-screw Nut, Thread Lengths up to 43 Inches are within the Capacity of the Machine

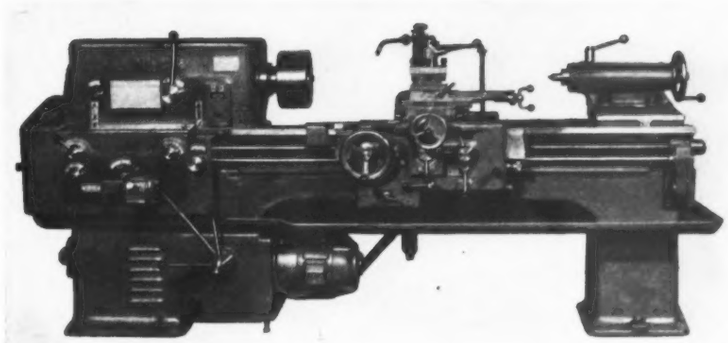
An Attachment to an Index Automatic Screw Machine which Permits of Turning Wide Surfaces to a Profile when Forming Tools Cannot be Used Conveniently. A Cam Drum Controls the Cross-slide Independently of the Turret-slide, so that Tools in the Latter may be in Operation at the Same Time as the Profiling Tool



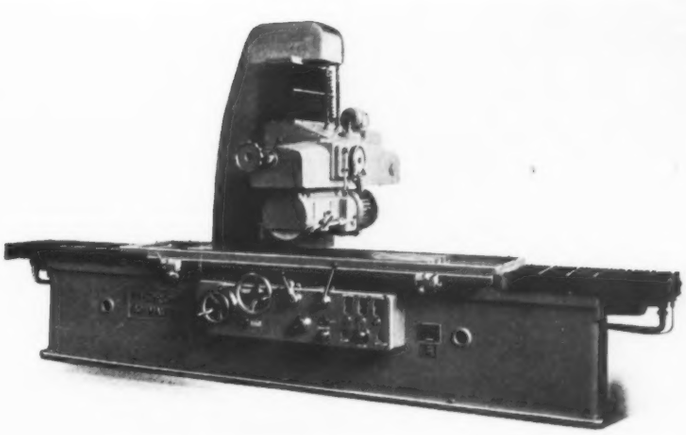
A Reinecker Crankshaft-grinding Machine in which All Movements of Table, Wheel-head, and Work-holding Fixtures are Hydraulically Operated

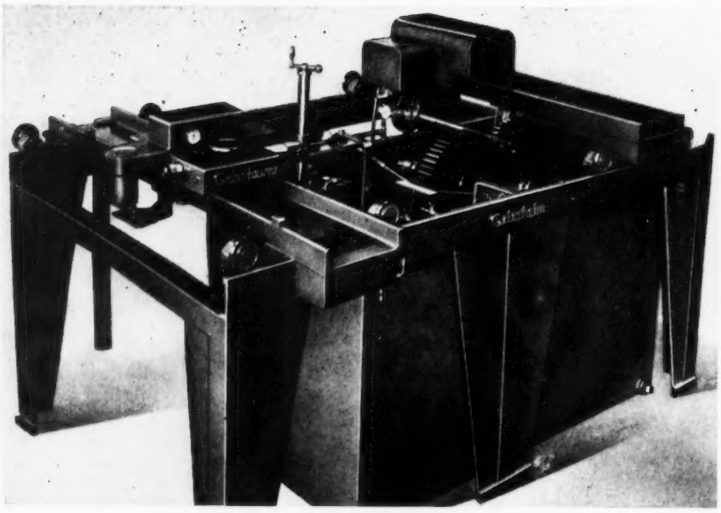


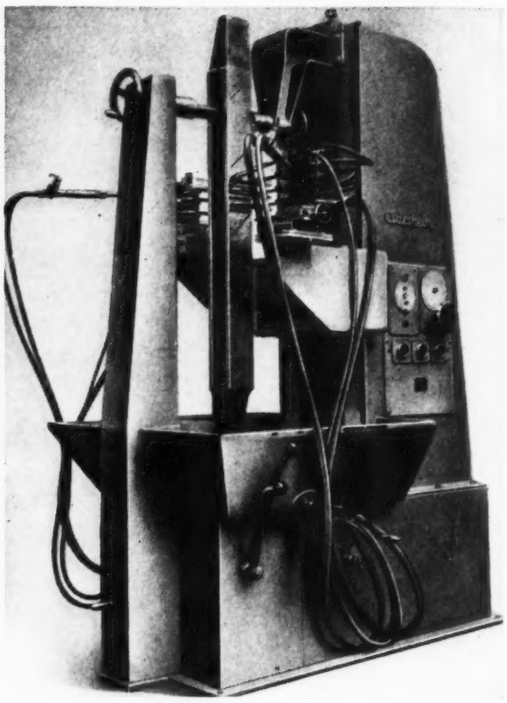
A Lathe of Modern German Design that was Exhibited by the Deutsche Niles Works. This Design of Lathe is Regularly Made in 16- and 18-inch Sizes

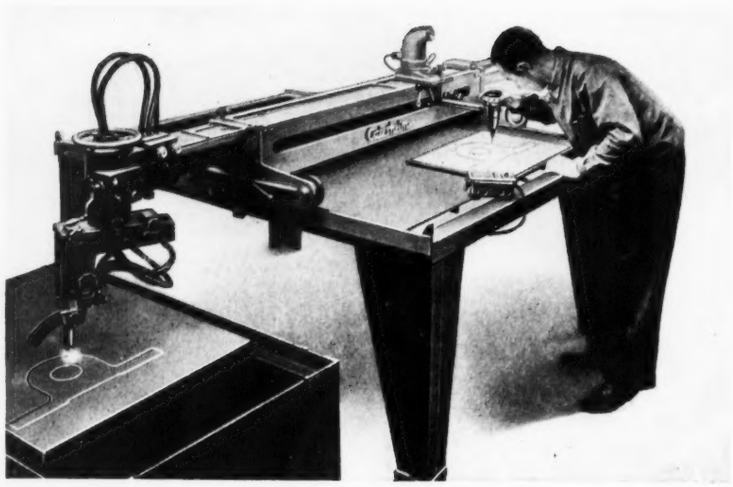


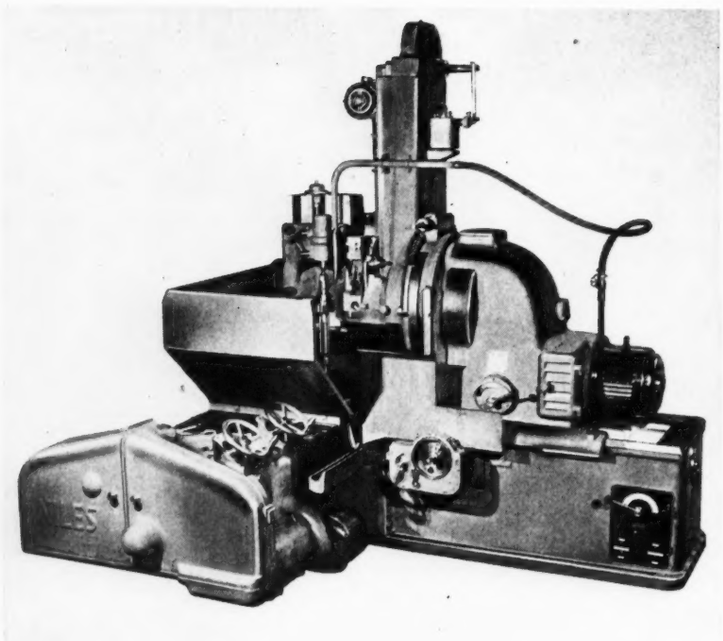
A Schmalz Surface Grinder with Hydraulically Reciprocated Table. Note the Bellows Type Guards Protecting Both Ends of the Bed Ways and the Upright Slide Ways from Grit and Dust





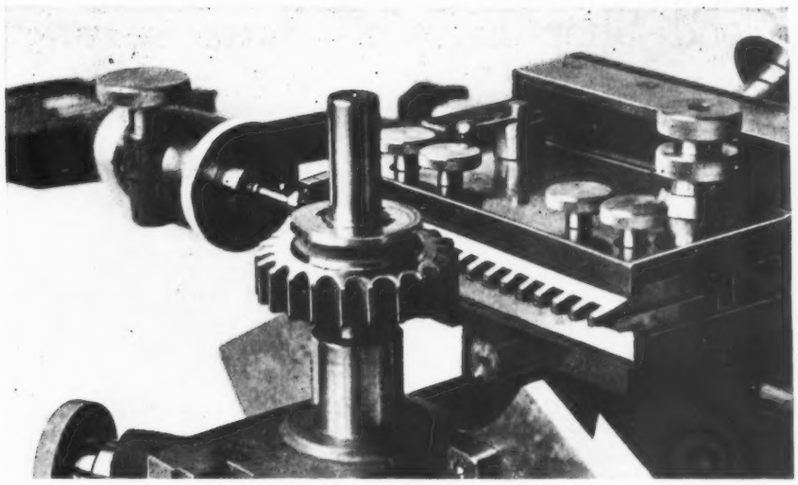






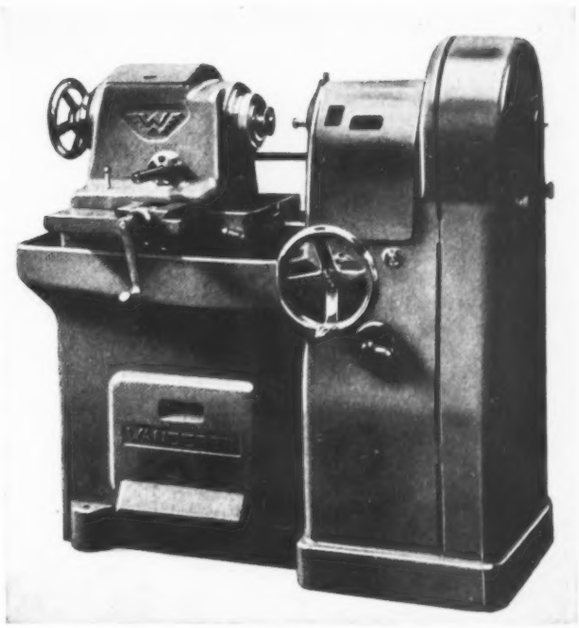
The Illustration in the Upper Left-hand Corner Shows a Fully Automatic Flame-hardening Machine for Hardening Gears that was Exhibited by Griesheimer Autogen Verkaufs-G.m.b.H., in which the Flame, the Water Jet, and the Indexing of the Gear Teeth are Automatically Controlled. To the Right, Above, is Shown a Griesheim Automatic Flame-hardening Machine Designed for Hardening Large Flat Wearing Surfaces, Such as Guide Bars for Locomotives, One of which is Shown in Place in the Machine. In the Center of the Page is Shown a Griesheim Flame-cutting Machine. The Operator Follows the Outline of a Drawing while the Cutting Torch Cuts Out the Corresponding Shape from a Plate

(Left) A New Type of Gear-tooth Grinder Built by the Deutsche Niles Works. The Machine is Made in Four Sizes, for Gears as Small as 1 1/4 Inches and as Large as 4 Feet in Diameter

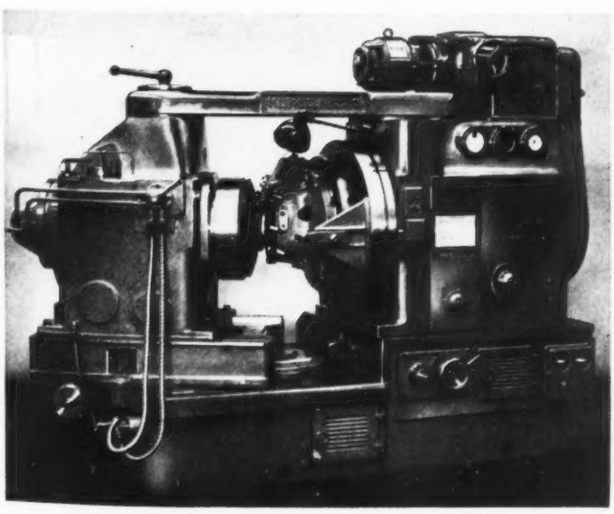


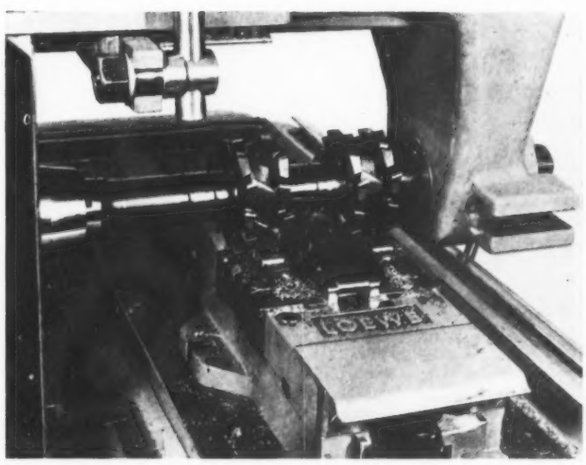
(Above) A Gear-testing Machine Built by Reindl & Nieberding, in which, through an Ingenious Arrangement of a "Double-faced" Rack that is Made in Two Sections Adjustable with Relation to Each Other, Very Accurate Tests of Gears are Possible. To the Right, Above, is Shown a Close-up View of the Machine

(Right) A Wanderer Short Thread Milling Machine Chiefly Used for Milling Fine Threads, External or Internal. The Machine Uses a Thread Milling Cutter at Least as Wide as the Thread Length to be Produced. After Starting the Machine, the Cutter Automatically Approaches the Work, Feeds to the Full Thread Depth, Completes the Thread in One Revolution of the Work, and then Automatically Returns and Stops



(Below) A Gear-lapping Machine with a Swinging Lapping Head. This Machine was Exhibited by Klingelnberg Soehne





A Loewe-Gesfuerel A.G. Milling Machine Operating on Three Surfaces of Two Steel Parts Simultaneously. Cutting Speed, 67 Revolutions per Minute; Feed, One Inch per Minute; Tolerance, 0.0015 Inch

Good Shop Lighting Reduces Fatigue and Improves Work

Fig. 1. Light on Work but Dark Surroundings

Fig. 2. Too Little Local Lighting on Work

Fig. 3. Proper Kind of Work Illumination

CONCENTRATED local lighting at the point of work on a machine tool, supplemented by general lighting not less in intensity than one-tenth of the local lighting on the tool, provides the best seeing conditions, according to Westinghouse lighting experts. Fig. 1 shows local lighting which provides plenty of light on the work but causes fatigue and eyestrain due to the severe contrast with the remainder of the room, which is in comparative darkness. In Fig. 2 is shown a case of good general lighting, but the illumination is not adequate for precision work. It is not economical to increase the intensity of the overhead illumination to provide a sufficient amount of light at the work. In Fig. 3 is shown the right way of lighting a machine shop for accurate work. There should be local lighting at the point of work combined with general lighting of the shop itself.

* * *

Everybody Helps to Pay for the High Cost of Government

According to data collected by M. B. Kwait of New York City, taxes are absorbing a constantly greater share of the earnings of workers and stockholders alike. In 1936, the General Motors Corporation paid taxes equivalent to $440 for each worker employed, an increase of more than $100 over the previous year. For every telephone in service, the American Telephone & Telegraph Co. paid $8.36 in taxes. Many utilities are taxed up to $1000 for each employe. One large public service corporation pays as much in taxes as in salaries and wages. The dividends of thirty-seven corporations, representing various industries, with more than 2,500,000 stockholders, averaged $2.80 per share, while taxes averaged $3.23 for every share. Furthermore, an average of more than 25 cents of every dollar paid in rent by tenants goes to pay the taxes of the landlord. It is about time that budgets were balanced and emergency taxes discontinued!

* * *

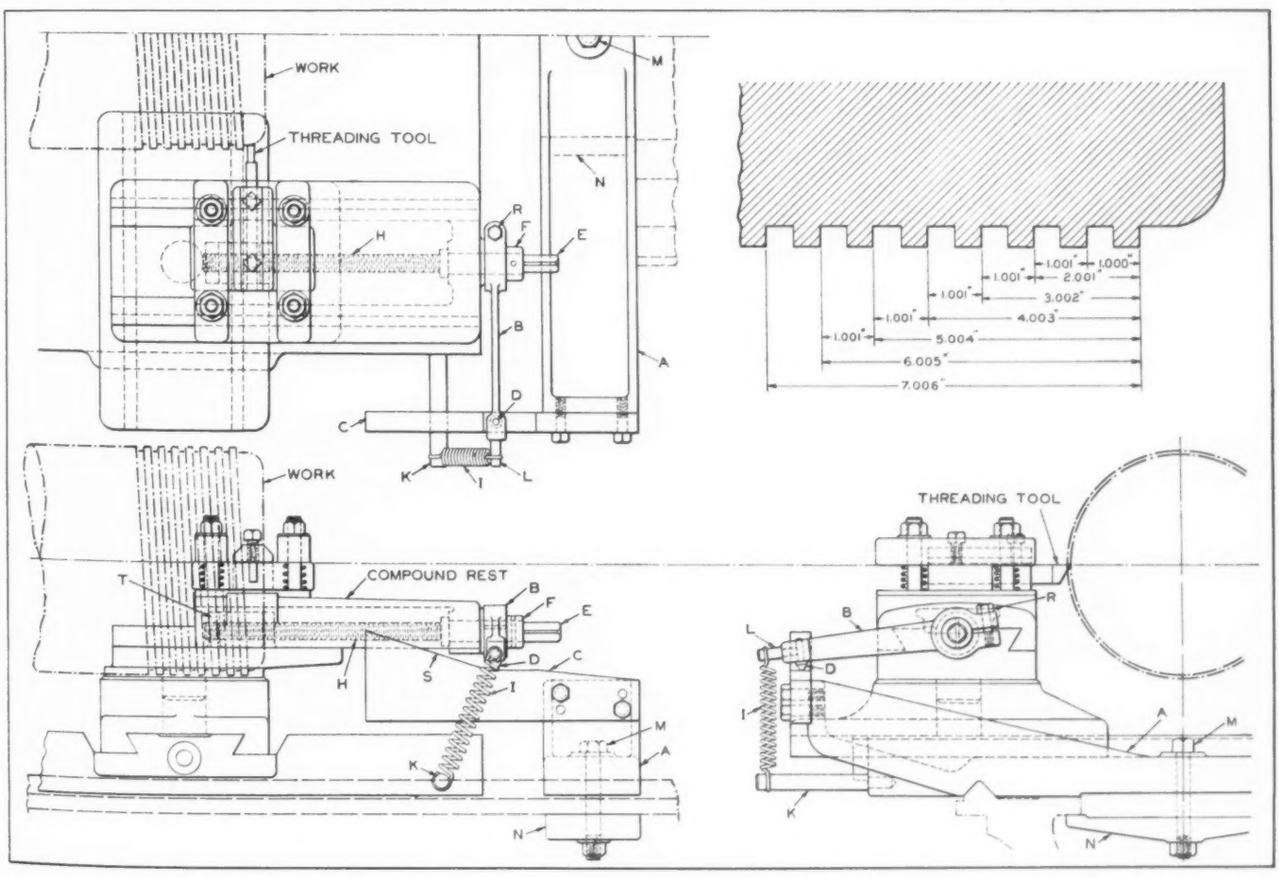
Machinery Exports Above Last Year

The United States exports of industrial machinery during the month of April, the last month for which complete statistics are avaliable, were valued at $23,672,600, a 10 per cent increase over the corresponding month last year. According to the Machinery Division of the Department of Commerce, exports of power-driven metal-working machinery continue to show a marked improvement over last year, aggregating $7,861,500 during April, 1938, as compared with $5,119,700 in April, 1937. Increases in exports were especially noted in turret lathes, boring mills, and milling machines.

Lathe Attachment for Cutting a Square Thread with an Increasing Lead

By J. R. WHITTLES, Holden, Mass.

The attachment shown in the accompanying illustration is used on a 36-inch lathe for cutting a square thread having a progressively increasing lead. The lead of the thread cut with this attachment increases progressively at the rate of 0.001 inch per inch, as shown in the cross-section view in the upper right-hand corner of the illustration. This increase in lead is obtained by advancing the tool carriage uniformly with the regular lead-screw as required for a lead of 1 inch, and in addition, simultaneously increasing the lead 0.001 inch for each complete turn by means of the attachment. This particular thread is cut with an increasing



Attachment Used on 36-inch Lathe for Cutting Square Thread with Increasing Lead

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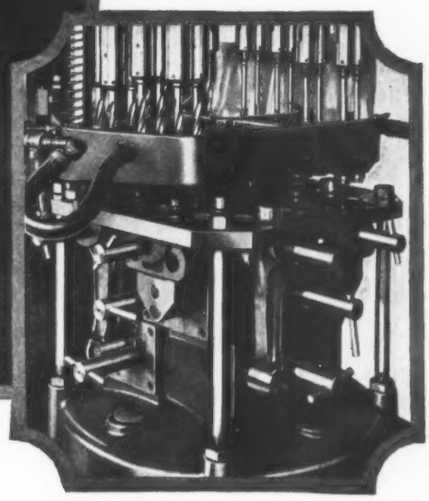
Design of Tools and Fixtures



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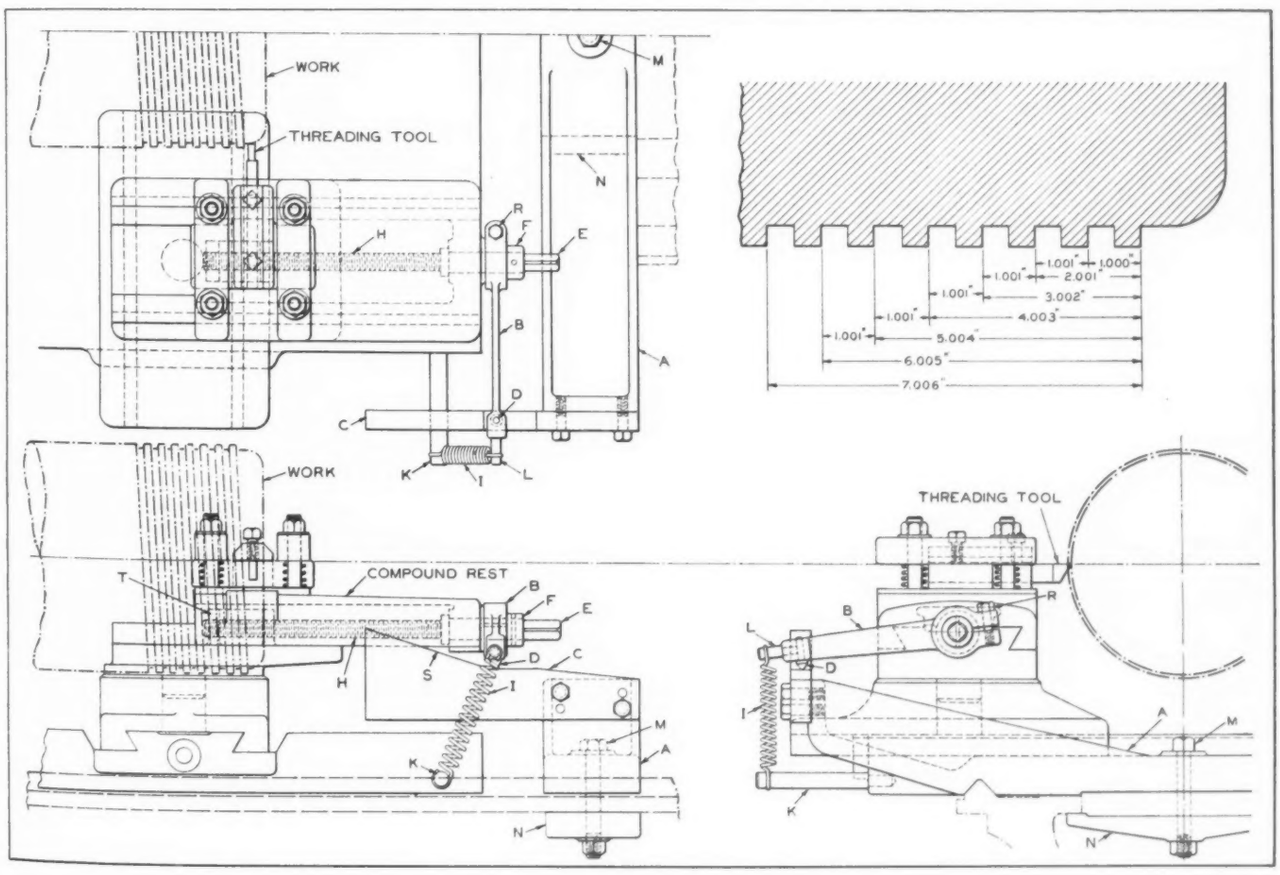


Attachment Used on 36-inch Lathe for Cutting Square Thread with Increasing Lead

lead to allow the mating piece to be threaded on with a very tight fit.

The increase in lead is obtained by allowing the round-nose pin *D*, attached to the lever *B* on feed-screw *H*, to ride up the incline *S* of the straight-faced cam *C*, and thus turn screw *H* in nut *T*. This causes the tool to advance in the same direction as the regular feed. Although, theoretically, a slight error results from using a straight-face cam, due to the angular motion of pin *D* in rising, the error is so small that it cannot be detected on the finished piece, especially if the lever *B* is positioned to travel the same distance above and below the horizontal center line of the screw *H*.

When the threading tool is in position to cut the first thread, lever *B* is clamped to cross-feed screw *H* by the cap-screw *R*. The cast-iron bracket *A* fits the ways of the lathe bed and is held in place by the bolt *M* and the strap *N*. The hardened steel cam *C* is secured to the end of bracket *A* by two cap-screws and dowel-pins.

The screw *H* is made with a square end at *E* to facilitate adjustment by hand when locating the threading tool in the proper position for cutting the thread. The collar *F* which holds lever *B* in place endwise is pinned to screw *H*. Screw *H* has a 5-pitch Acme thread. The spring *I* serves to keep the point of pin *D* pressed firmly against the cam face *S*. Spring *I* is attached to the pins *K* and *L*. Pin *L* is pressed into a hole in the end of lever *B*, while pin *K* is fitted into a drilled hole in the tool carriage. Lever *B* operates automatically when the tool carriage is traversed in cutting the thread on the work.

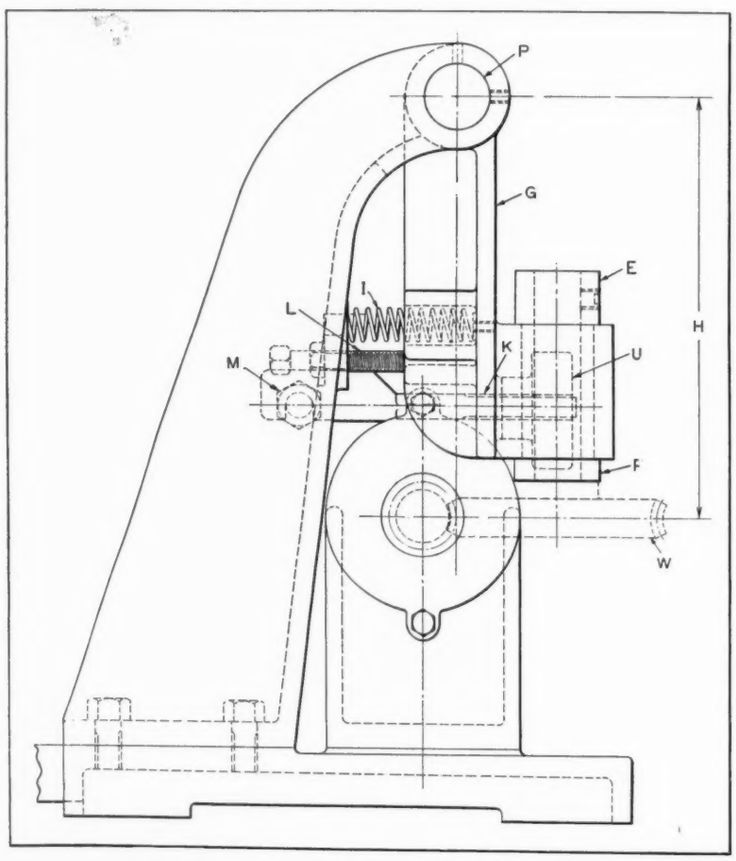


Fig. 1. End View of Worm and Worm-wheel Lapping Fixture

Worm and Worm-Wheel Lapping Fixture

By CLIFFORD CORNWALL, Toronto, Canada

While the method most commonly used today for producing worm drives involves the grinding of the hardened worm, very little seems to have been done about finishing the worm-wheels other than to hob them as accurately as possible. This method produces good worm drives, but where extremely quiet operation is desired, the writer has found that more satisfactory results are obtained by lapping the worm-wheels on the fixture shown in Figs. 1 and 2.

For the particular set-up shown, the carburized and hardened worm *A* is mounted on its own shaft which is slipped into a snug fitting, hardened and ground sleeve *B*, of which there are three sizes varying by 0.0002 inch. These three sizes of sleeves take care of slight variations in worm-shaft diameters. The sleeves are made a close slip fit for the spindle, and the whole assembly is held in place with a set-screw *C*, which forces a brass plug *D* against the worm-shaft.

Double-row ball bearings mounted on 11-inch centers are provided for the spindle to insure steadiness and to offset the effects of wear and looseness which might result over a long period of time. The thrust load is carried by the bearing at the pulley end, as indicated by the cross-section, the other end of the spindle being allowed free movement in the bearing to take care of expansion or contraction. The spindle is driven at a motor speed of 1450 revolutions per minute and is lubricated by removing the bearing-retaining plates and repacking with grease.

The retaining collar *E* holds the worm-wheel *W* in place when fastened tightly to the end of the worm-wheel shaft, and carries what little downward load results from the lapping process. The hardened and ground bushing *F* is pressed into place. A little oil placed on the shaft on which the worm-wheel is mounted provides lubrication for this shaft during the lapping operation.

The hinged supporting arm *G* swings about the center of the hinge-pin *P* located perpendicularly above the point of tangency of the worm and worm-wheel pitch circles. As the center distance *H* is 8 inches, the perpendicular movement of the worm-wheel on the arc, for an in feed of about 0.005 inch when lapping, is so slight that it can be disregarded. A fairly stiff spring *I* presses the arm *G* against the face of

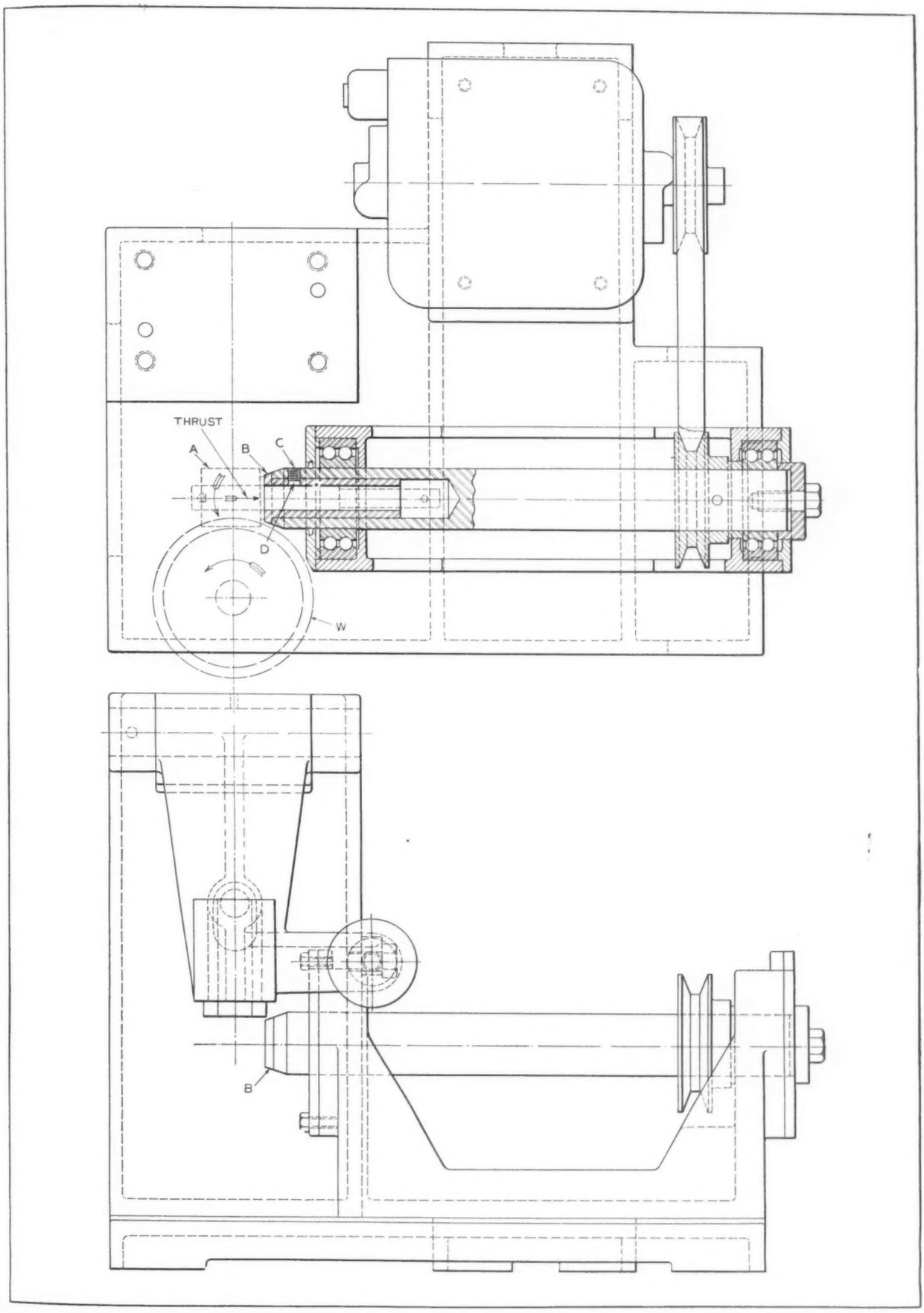


Fig. 2. Plan and Front Views of Lapping Fixture Shown in Fig. 1

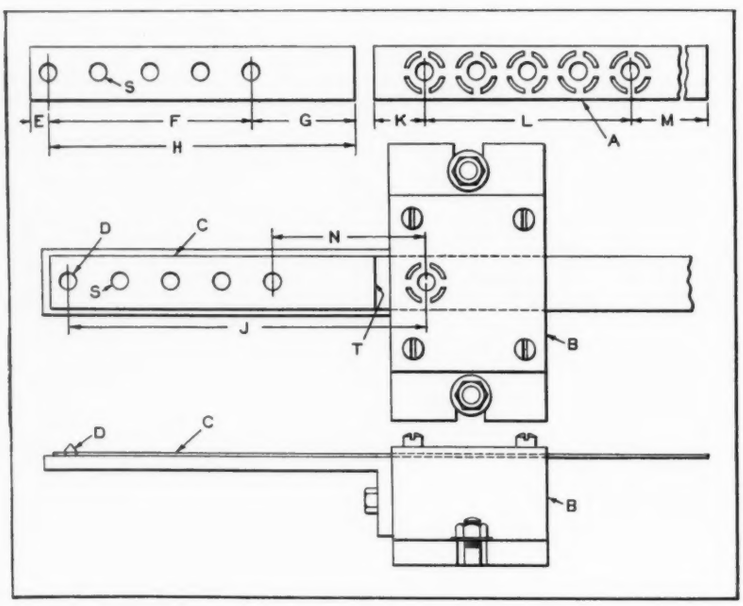
the handwheel *U* on the feed-screw *K*. Handwheel *U* is turned at short intervals as the lapping-in removes any roughness and high spots from the worm-wheel. The set-screw *L*, when once set for the proper center distance, is unchanged. The arm *G* reaches the set-screw stop *L* in about a minute's running time. When lapped in this manner, a smooth, quiet running worm-wheel is assured.

Various methods may be employed to handle the work. The worm can be mounted between ball-bearing centers, for example, or it can be made to rotate on the bearing portions of its shaft. By lifting the feed-screw from the bolt *M*, the arm *G* can be swung up at an angle to facilitate loading and unloading. The lapping mixture of flour emery and machine oil falls into a sheet-metal receptacle on the bed of the fixture where no harm can result. This lapping mixture is used over and over again, care being taken to see that it is thoroughly remixed after being collected in the sheet-metal receptacle.

Die for Punching Irregularly Spaced Holes

By L. KASPER, Philadelphia, Pa.

Pieces such as shown at *A* in the accompanying illustration are made up in small lots in which the spacing of the punched holes varies. As other operations follow the punching or piercing operations, it is desirable to punch the holes in the strip, perform the other operations, and then cut the strip into the required lengths. As the number of pieces made with each specified spacing is comparatively small, a quick and accurate method of locating the holes is desirable.



Die Provided with Interchangeable Templet C for Controlling Spacing of Punched Holes

As each strip is started through the die *B*, it is brought into contact with the end *T* of templet *C*, which is located by placing the end hole over pin *D*. After the first hole is punched in the strip, the templet *C* is relocated, with the next hole *S* placed over pin *D*. This method of relocating and punching is continued until one complete set of holes is punched in the strip. The templet *C* is then removed. As the spacing of the holes thus punched in the strip is the same as that in the templet, the punching of the strip is continued by placing each successive hole already pierced over the pin *D*. Each set of holes punched will be a duplicate of the previous set.

The templet *C* is simply a piece of strip metal, in which the locating holes are drilled. Referring to the lay-out of the templet, the dimension *E* is unimportant. The dimension *F* must equal dimension *L* of the blank, and the other holes must be properly spaced. Dimension *G* of the templet equals *M* of the blank. Dimension *H* of the templet represents the over-all length of the blank minus *K*.

In locating the stop-pin *D*, the dimension *J* must equal the over-all length of the blank. The dimension *G* on the templet is important only as it affects the starting of each strip. As the center distance *N* is equal to the sum of *G* and *K*, any increase or decrease in *G* produces an opposite change in the dimension *K* of the first blank punched, although the balance of the strip will be accurately spaced. With this method, the possibility of error is greatly reduced, and the "down time" of the press ordinarily required for changing stops, checking, etc., is eliminated.

* * *

With the present-day hours and wage rates in industry, it will become more difficult than ever for the high-cost plant to compete with those plants that are equipped with modern machinery and organized along efficient lines, so as to bring down their costs to a minimum. In those branches of industry where there is a decided over-capacity, these high-cost plants will be unable to hold their own and may gradually go out of business. This, while imposing individual hardships, will benefit the industry as a whole, since it will bring the capacity more nearly in line with consuming ability.

The way in which the present high-cost plant can save itself is by bringing its costs in line with those of the industry as a whole, which can generally be done by installing new and efficient machinery and by organizing along modern lines. Often, outside engineering firms who specialize in plant organization can be helpful in this work. It is often easier for an outsider to recognize weaknesses in methods, than for one too closely identified with the work.

Using Broaches with "Pyramid" Shaped Teeth

BREAD-BAKING machines require iron or Ni-Resist castings of the type seen on the floor in the accompanying illustration, which have a series of rectangular holes that extend the full length of the castings. These cored holes must be finished to uniform dimensions and to a high degree of smoothness to insure the baking of identical loaves of bread.

The broaching equipment illustrated was recently built by the Lapointe Machine Tool Co., Hudson, Mass., for finishing the holes in these "pocket division boxes." The machine is a standard 4L type with a normal pulling capacity of 73,000 pounds, a maximum cutting speed of 18 feet per minute, and a maximum return speed of 90 feet per minute. The machine is operated by a West variable-delivery reversible-discharge hydraulic pump connected to a 20-horsepower motor. An infinite range of ram speeds is obtainable in either direction by merely moving the starting handle. A fixture is attached to the faceplate for holding the work; there is a tray for handling and guiding the heavy broaches.

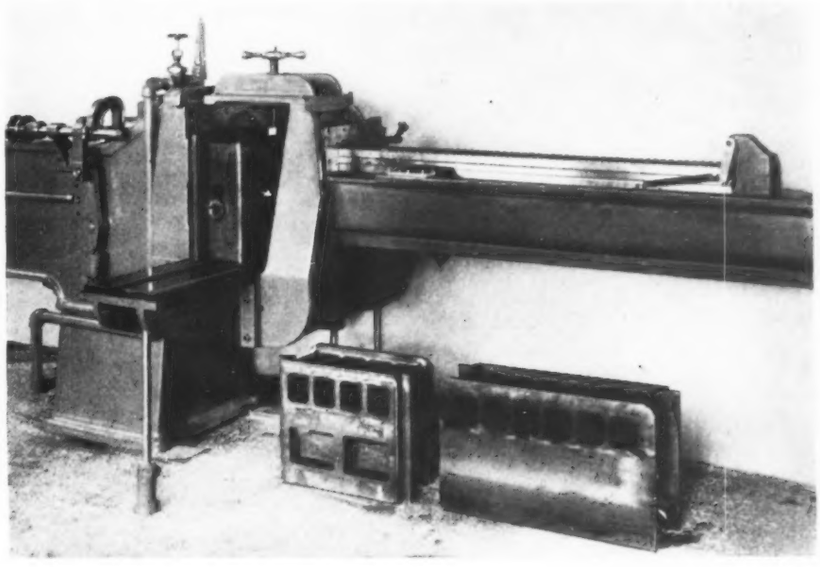
Three broaches are used to finish each hole, two for roughing and one for finishing. From 1/8 to 3/16 inch of stock is removed from each surface. The first teeth of the two roughing broaches (which are of a patented design) cut a series of sharp V-shaped grooves well under the scale. These teeth are followed by others that cut sideways, widening the grooves until they run into each other. This broaching method, using "pyramid" shaped starting teeth, reduces dulling of the teeth by avoiding contact of the cutting edges with the hard scale, and also provides a substantial saving in power for the operation. It is especially suitable for the broaching of castings, since sand and scale are practically inevitable on cast surfaces. It is generally impossible to have the first tooth of a broach cut deeper than the scale; however, by using broaches with pyramid-shaped starting teeth, the dulling effect can be greatly minimized.

The first broach cuts both vertical sides of the rectangular holes in the casting within 0.010 inch of the finished size. This broach is guided by two sets of keys on the horizontal sides of holes in the fixture, there being one set of keys at each end of the work for properly aligning the broach. The fixture is equipped for indexing from each hole to the next. A fine-thread hand clamp is used to fasten the work to the fixture.

The second broach cuts the top and bottom of each hole within 0.010 inch of the finished size. This broach is guided by keys in slots located on the vertical sides of the fixture holes. The third broach is of a sectional type and finishes all four sides of the holes. The first cutting portion of this broach has teeth on two adjacent sides, followed by teeth on the other two adjacent sides. There is then a broach shell which has teeth for cutting the full contour of the holes. This shell can be replaced as it becomes worn, without replacing the entire broach.

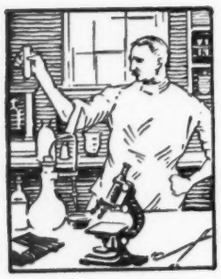
Behind the shell there is a long extension for securely holding the tool by means of the guiding tray at the rear, as well as by the holder at the front. All guide keys are removed from the fixture when the finishing broach is used. This broach machines the holes to the specified dimensions within a tolerance of 0.001 inch. There is an allowance of 0.005 inch on the center-to-center distances between the holes.

At no time during the broaching cycle is it necessary for the operator to handle the heavy broaches manually. An air cylinder on the broach support tray pushes the broach shank through the work to the puller prior to each operation, and pulls the broach back to clear the work after the operation has been completed. Although this broaching operation can be performed dry, a better finish is obtained and less power is required to pull the broaches through the work by using kerosene as a coolant. It is estimated that by the use of this procedure, the savings over former methods will pay for the cost of the fixture and tools in broaching only a few hundred castings.



Broaching Machine which Employs Two Roughing Broaches with "Pyramid" Teeth and a Finishing Broach for Machining Holes in Castings for Bread-baking Machines

MATERIALS OF INDUSTRY



THE PROPERTIES AND NEW APPLICATIONS OF MATERIALS USED IN THE MECHANICAL INDUSTRIES

Inland Ledloy—Lead-Bearing Free-Cutting Steels

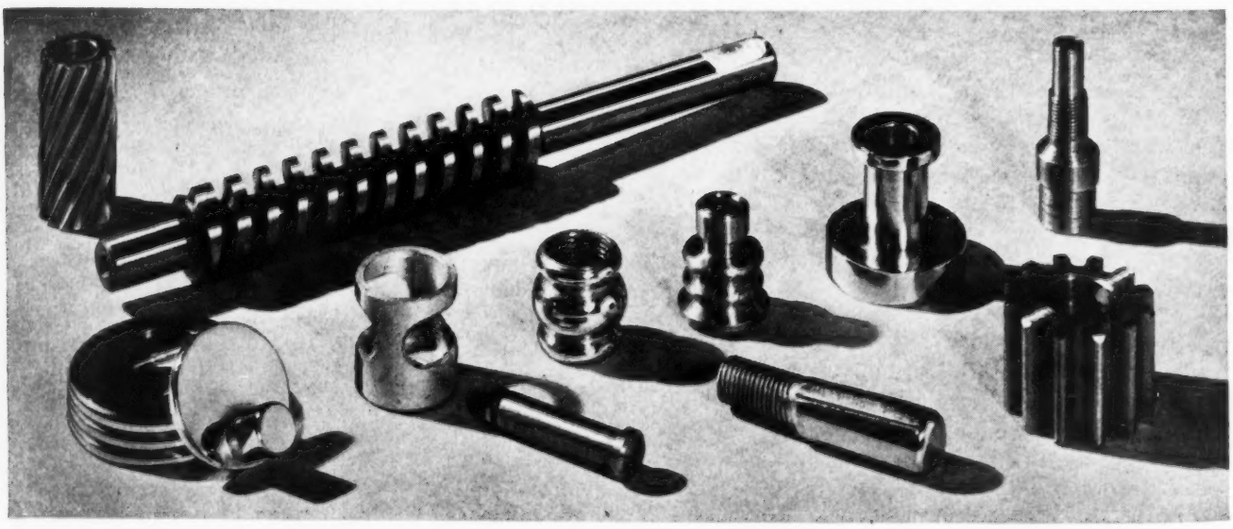
After a long research into the problem of producing an open-hearth steel of easy machineability, the Inland Steel Co., Chicago, Ill., is introducing Ledloy to the trade. This name has been copyrighted for steels of any composition in which lead is alloyed.

The process developed by the concern mentioned for the production of Ledloy insures the uniform distribution of lead throughout the steel, the lead being in such a fine state of dispersion that it cannot be seen under a microscope. In this form it has no effect upon the physical properties of the steel but considerably increases the rate at which it can be machined. Lead is usually added in amounts of from 0.15 to 0.30 per cent.

Ledloy 1120 is said to machine from 30 to 60 per cent better than standard SAE 1120 steel and also much more easily than SAE X-1112 high-sulphur Bessemer screw stock. The improved machineability of Ledloy is not confined to cold-drawn or regular screw stock grades, however, as tests have indicated the possibility of increasing production by alloying the higher carbon grades of steel with lead.

The physical properties of Ledloy are the same as for other steels of like analysis produced without the addition of lead. The strength, ductility, and resistance to impact are also unchanged. Ledloy of any analysis can be carburized and treated in the same manner as ordinary carbon steel. The presence of lead does not change the carbon penetration and has no effect upon the normality of the steel. In the higher carbon and alloy analyses, the use of lead does not require changes in the methods of heat-treatment. Ledloy quenches to the same hardness and can be drawn to the same physical properties as the same steels of standard compositions.

Ledloy is made by the Inland Steel Co. in all hot-rolled forms and is cold-finished by leading producers of cold-drawn steel. Important savings can be effected in the machining time of a large variety of parts, including gears, crankshafts, spindles, spline shafts, etc. Typical parts that have been machined from Ledloy are shown in the accompanying illustration. 201

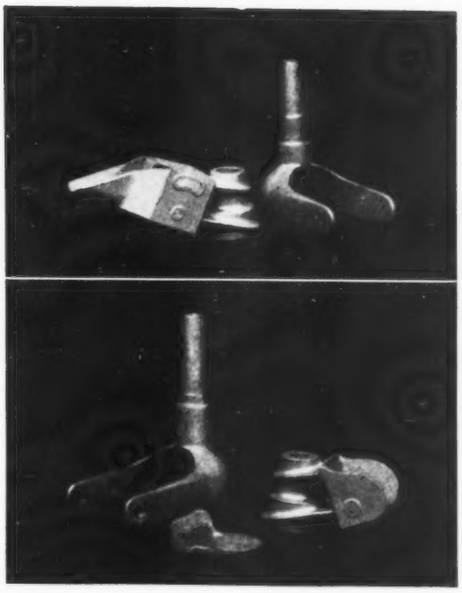


A Variety of Parts that have been Machined from Cold-finished Ledloy—Lead-bearing Steels being Introduced on the Market by the Inland Steel Co.

Malleable-Iron Parts in Aircraft Building

Malleable-iron castings are used in the two types of aircraft tail-wheel assemblies here shown, which have been developed by the Lancaster Malleable & Steel Corporation, Lancaster, N. Y. One of these assemblies was designed for attachment to the tail spring leaf of a Rearwin cabin monoplane and the other for attachment to the skid tube on an Aeronca cabin monoplane.

Three castings are required for the spring leaf assembly—a fork, bracket and attaching plate; while for the skid-tube model, only a fork and bracket are required.



Malleable-iron Castings Used in the Tail-wheel Assemblies of Airplanes

A combination of alloys is used for the fork castings to obtain high strength characteristics after heat-treatment. The brackets are cast and treated as normal malleable-iron castings. Weight is held to a minimum on the different parts, by the provision of suitable ribs and fillets. 202

Aircraft Engine Equipped with Ni-Resist Liners

A light aircraft engine which develops 50 horsepower at 2400 revolutions per minute has been announced by the Aircooled Motors Corporation, Syracuse, N. Y. This engine has a 3 5/8-inch bore and a 3 5/8-inch stroke which gives a displacement of 150 cubic inches. By making the stroke no longer than the bore, the piston speed is held down and it is possible to use valves that are large in relation to the size of the cylinder.

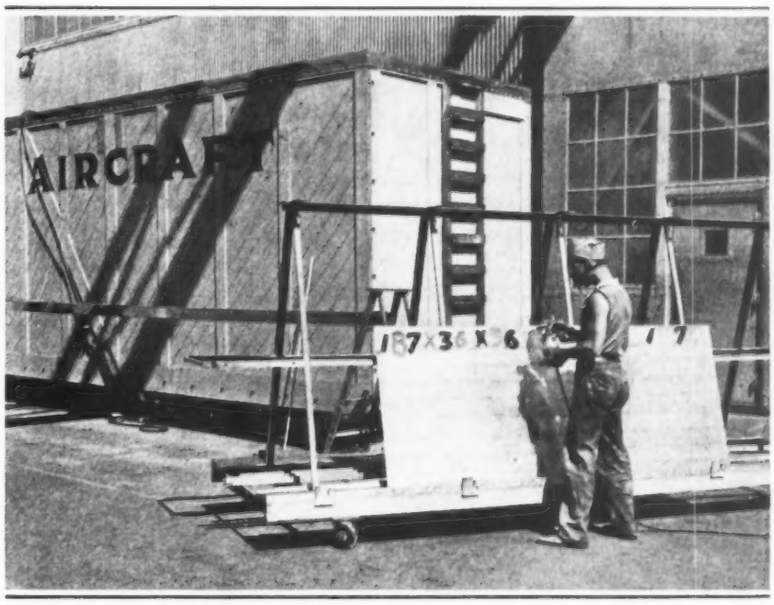
The cylinders are cast individually with the valve-rocker box integral. The castings are made from British Y-alloy (2 per cent nickel-aluminum alloy) which has given very satisfactory service in heavy-duty engines. Into each cylinder, according to *Nickel Cast Iron News*, published by the International Nickel Co., Inc., New York City, there is shrunk a liner of Ni-Resist, the corrosion-resistant nickel-copper-chromium iron. This alloy has a coefficient of heat expansion approximately equal to that of the Y-alloy cylinder casting, so that a good metal-to-metal contact is maintained between them. The valve seats and the exhaust-valve guides are also made of Ni-Resist. 203

Preventing Corrosion by Spraying with Corol

Corol, the rust preventive manufactured by the Simoniz Co., 2100 Indiana Ave., Chicago, Ill., is used extensively by the manufacturers of airplanes to prevent the corrosion of metal parts on planes that are to be exported. In the illustration, an operator is seen spraying hot Corol on a large sheet of aluminum alloy at the plant of the Consolidated Aircraft Corporation, San Diego, Calif. The sprayed sheets will be packed in the export box seen in the background. Corol can be applied to metal surfaces even when they are damp, as it will displace any water that may be present on the surfaces.

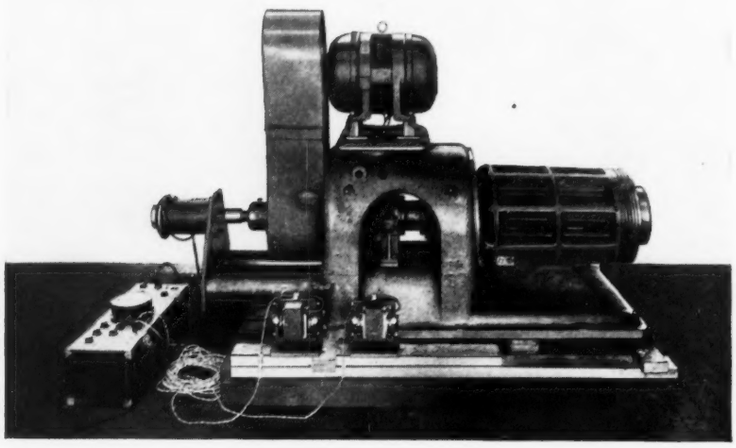
Smaller machine parts, castings, etc., are generally dipped in Corol at the Consolidated Aircraft Corporation before being packed for export. When Corol-treated parts reach their destination, the rust preventive film can be easily removed.

Inasmuch as airplanes represent very great investments, and, furthermore, since their operation depends almost entirely upon the perfect condition of all parts, the prevention of corrosion is of the greatest importance. 204



Spraying Corol on Aluminum-alloy Sheets to Prevent Corrosion during Ocean Transportation

A New Simplified Balancing Machine



Dynamic Balancer Connected to Balance a Centrifugal Casting Machine

A NEW balancing machine has been developed by the research laboratory of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This machine simplifies the work of balancing rotors "on location"—that is, when already assembled in their respective machines. The new balancing outfit can be carried in two suitcases. It eliminates the time-consuming trial-and-error methods frequently used in the past. It reduces the number of trial runs to two or three, and simplifies the determination of the exact correction weight position. The work of balancing is reduced to simple meter readings and elementary arithmetic.

The equipment is provided with a vibration pick-up that is held against the vibrating body. It is stated that the balancer can be used for the most complicated cases of vibration. It has been used to determine the balance weight for a 165,000-kilowatt generator rotor. Another rotor that had been out of balance for fifteen years was balanced by adding weights in four transverse planes, as indicated by the new device. Another machine required balancing for smooth operation at two speeds, which was easily accomplished.

The German Machinery Industries

ACCORDING to recent statistics, there are at the present time in Germany 4700 plants manufacturing machinery of different kinds. Of these plants, approximately 3500 employ less than 100 men each; 1050 employ from 100 to 1000 men; while 150 plants employ over 1000 men each.

The number of plants specializing in the building of machine tools is approximately 250 although, of course, there are many additional plants that build some machine tools, either for their own use or as a side line. Many of the machine tool plants are quite large; at least five employ 3000 men or more.

In all the machine-building plants, approximately 700,000 people are employed, of whom somewhat over 100,000 are salaried workers. About 510,000 people are engaged as productive shop workers; of these, about 300,000 are skilled all-around machinists and toolmakers; 115,000 are machine operators who, while not all-around machinists, in many instances are highly skilled in the operation of one or more machine tools. About 70,000 are classified as helpers, while about 25,000 are women workers, generally employed on light machine and assembly work, as, for example, in the electrical industries.

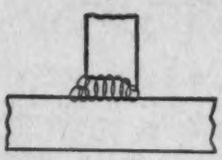
In 1936, Germany exported 30 per cent of the world's machinery exports, having the largest machinery exports of any single country. During the first six months of 1937 the machinery exports were 27 per cent greater than in the corresponding period of 1936, indicating a continued increase in German machinery exports. These exports were well distributed all over the world, except, of course, to such countries as the United States, where a highly developed machinery industry supplies the nation's own domestic needs.

Europe is, of course, the largest customer for German machine tools. During the first six months of 1937 Europe absorbed 83 per cent of the exports. The exports to North and South America amounted to 6 per cent of the total. The value of machine tool orders booked during the first six months of 1937 was 40 per cent greater than during the corresponding period of 1928. The number of orders booked at the present time, however, does not really represent the total demand, since many additional orders would be placed if reasonably early deliveries were possible. Most of the larger machine tool plants in Germany are unable to deliver domestic orders now placed until 1940. Export orders are given preference, since Germany is eager to maintain and develop her export trade; hence fairly early deliveries are quoted for export.

Germany supplies from 97 to 98 per cent of her own machinery needs. One interesting fact about the German machinery industry is that Germany, perhaps more than any other country, supplies machinery for highly specialized industries, for which the demand is very small. This, in many instances, has furnished an export market.

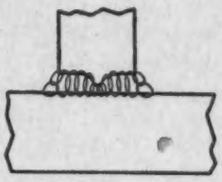
MACHINERY'S DATA SHEETS 373 and 374

TYPES OF ARC-WELDED JOINTS AND THEIR APPLICATIONS—3



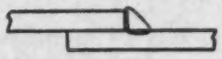
Single-U Tee Joint

The Single-U Tee Joint is suitable for severe loads; and while it can be used for plates of unusual size, it is generally applied to plates 1 inch or more in thickness. The welding is done from one side only. However, it is advisable to put in a final welding bead on the side opposite the U. Although this type of joint is somewhat more costly to machine than the single-vee joint, the single-U tee joint is lower in electrode cost.



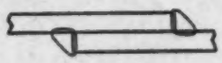
Double-U Tee Joint

The Double-U Tee Joint is suitable for exceedingly severe loads of all types in heavy plates 1 1/2 inches thick and more, where welding can be done from both sides. Although the machining costs for the double-U tee joints are higher than for the other types of tee joints, less electrode material is required; consequently, the cost per joint is reduced.



Single-bead Lap Joint

The Single-bead Lap Joint is frequently used, and has the advantage of requiring practically no machining to fit the edges of the plate. When fatigue or impact loads are encountered, stress distribution should be carefully studied. In cases where the loading conditions are not too severe, the single-bead lap joint is suitable for welding plates of all thicknesses.



Double-bead Lap Joint

The Double-bead Lap Joint is suitable for loading conditions much more severe than can be satisfactorily met by the single-bead lap joint. In general, the two beads should be full size, although one bead may be smaller than the other in some instances. Because of its lower cost, the double-bead lap joint is widely used; but for very severe loads, butt joints should be used.

MACHINERY'S Data Sheet No. 373, New Series, July, 1938 Compiled by the Lincoln Electric Co.

TYPES OF ARC-WELDED JOINTS AND THEIR APPLICATIONS—4

Flush-corner Joint

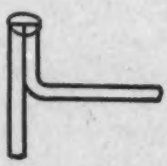
The Flush-corner Joint is suitable when the loads are not severe or when the plates welded are 12 gage and lighter. Although permissible for use on any plates, care should be taken to see that the loading is not excessive.

Half-open Corner Joint

The Half-open Corner Joint is suitable for loads where fatigue or impact is not severe. This joint is generally used on plates heavier than 12 gage where the welding can be done from one side only. The "shouldering" effect of the half-open corner type of joint aids in welding by reducing the tendency to burn through the plates at the corner during the process.

Full-open Corner Joint

The Full-open Corner Joint is suitable for severe loads in welding plate of all thicknesses where the welding can be done from both sides. When properly made, this joint is of such shape as to provide good stress distribution, thus permitting its application to fatigue or impact loads of all types.



Edge Joint

The Edge Joint is used in joining plates 1/4 inch thick or less where the joint will be subjected only to light loads. Careful consideration must be given to the load conditions, especially the impact and fatigue loads, as this type of joint is unsuitable for use where severe loads are encountered.

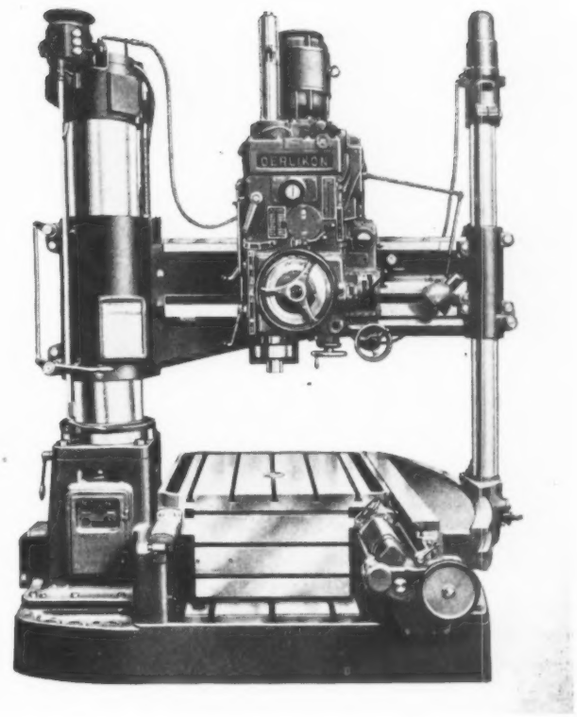
MACHINERY'S Data Sheet No. 374, New Series, July, 1938 Compiled by the Lincoln Electric Co.

A Swiss Combination Radial Drill and Jig Boring Machine

A radial drilling machine, which may also be used as a jig borer, has recently been brought out by the Machine Tool Works Oerlikon, Zurich-Oerlikon, Switzerland, a firm that has been known as a builder of high-grade machine tools for the last fifty years. In this country the firm has been best known for its early developments in gear-cutting machinery.

As will be noted from the illustration, the radial arm has an outboard support moving along a circular track, to which it can be secured in position, as desired. The machine is also provided with a table which can be moved accurately at right angles to the position of the boring arm when the latter is clamped in its central location. Hence, accurate jig boring can be performed by the combined movements of the table in one direction and of the drilling head at right angles to it in the other direction. When used as a jig-boring machine, the spacing of holes can be held accurately within a tolerance of 0.0004 inch. This accuracy is often sufficient for jigs and fixtures and especially for machine parts which can be drilled and bored directly in the machine without the use of a jig. The machine can drill to a radius of approximately 4 feet and has a capacity for drilling holes 2 3/4 inches in diameter in cast iron.

The most unusual feature of the machine, of course, is that it has the advantages of a conventional radial drill, but can, at the same time, be changed into a rigid frame-boring machine for rough- and precision-boring, and finally, when desired, into a jig-boring machine. Hence, it can be used either as a production machine or a tool-room machine, or as a combination of both. The firm of W. A. Schuyler, 250 W. 57th St., New York City, represents the Oerlikon company in the United States.



A Combination Radial Drill and Jig-boring Machine Built by the Oerlikon Works

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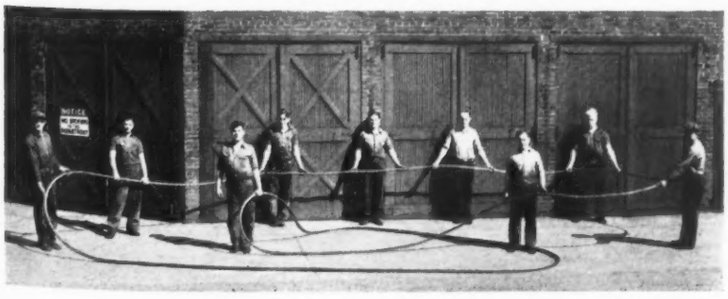
An Unusual Type of Endless Wire Rope

The endless wire rope shown in the accompanying illustration, usually known as a "grommet" and employed as a sling in lifting operations, measures 105 feet in circumference. It was manufactured for S. M. Christhilf & Co., Baltimore, Md., by the Williamsport plant of the Bethlehem Steel Co. This rope is made of high-strength 1 3/8-inch wire rope and is capable of lifting 80 tons. Rope of this kind is woven by hand and consists of one continuous strand wound helically six successive times around the entire 105-foot circumference, thus forming a truly endless circle of wire rope. Since the rope is of steel-center construction, the center strand, as well as the six outer strands, is woven so as to form one continuous length, with the ends located in the core.



An Endless Wire Rope Capable of Sustaining a Load of 80 Tons

* * *

When boring holes in soft rubber, such as used in rubber stoppers and for similar purposes, glycerine is said to be one of the best lubricants to use. After the holes have been drilled, if glass tubing is to be passed through the rubber, as in a stopper, glycerine will help to ease the tubing through the rubber. Since glycerine is completely soluble in water, it may be easily washed off after drilling and assembling.

NEW TRADE LITERATURE

Recent Publications on Machine Shop Equipment, Unit Parts and Materials. To Obtain Copies, Check on Form at Bottom of Page 797 the Identifying Number at End of Descriptive Paragraph, or Write Directly to Manufacturer, Mentioning Catalogue Described in the July Number of MACHINERY

Electric Equipment

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletins GEA-19H, "Magnetic Motor-Starting Switch"; GEA-743B, "Reversing Drum Switches"; GEA-2234B, "Manual Motor-Starting Switch"; GEA-2292A, "Magnetic Crane Control"; GEA-2679A, "Photo-Electric Relay for Automatic Light Control"; GEA-2907, "Alnico Limit Switch"; GEA-2908, "Oilproof Push-Button and Selector Switch"; GEA-2889, "Magnetic Motor-Starting Switches"; GEA-2052A, "Track Type Limit Switches"; GEA-1607B, "Direct-Current Generators and Exciters"; and GEA-67E, "Float Switches." 1

Frequency Recorders and Indicators

LEEDS & NORTHRUP CO., 4921 Stenton Ave., Philadelphia, Pa. Catalogue No. N-57-161, entitled "Micromax Frequency Recorders and Indicators," outlining the reasons for the increasing use of equipment for frequency measurement and frequency load control, as well as illustrating and describing instruments suitable for power plants, including industrial plants that generate their own power, and even for plants that buy it. 2

Machinists' Tools

L. S. STARRETT CO., Athol, Mass. Catalogue No. 26 entitled "Precision Tools, Steel Tapes, Dial Indicators, Hacksaws," containing complete descriptions and illustrations of more than 3000 improved tools and standard items in the Starrett line. The book also contains complete descriptions of fourteen new tools. In its 282 pages, it covers micrometers, verniers, dial indicators, gages, calipers, hacksaws, etc. 3

Hardness-Testing Equipment

TINIUS OLSEN TESTING MACHINE CO., 500 N. 12th St., Philadelphia, Pa. Bulletin No. 1, entitled "Olsen Testing Machines and Instruments," illustrating and describing a complete line of hardness testers of the Brinell, Firth, Herbert, and Ballentine types, as well as many special hardness-testing machines. 4

Shears and Flangers

NIAGARA MACHINE & TOOL WORKS, 637-697 Northland Ave., Buffalo, N.Y. Bulletin No. 70-D, entitled "Circle Shears, Ring Shears, Flangers, Slitters," illustrating and describing the company's complete line of this type of equipment, especially suitable for such operations as cutting fan shrouds; making airplane parts, steel drums, and containers; and many other similar uses. 5

Grinding Machines

LANDIS TOOL CO., Waynesboro, Pa. Catalogue No. N-138, illustrating and describing the company's 10-inch Type D hydraulic crankpin grinder especially intended for crankshafts, such as compressor crankshafts used in household electric refrigerators, motorcycle crankshafts, outboard motor crankshafts, small stationary engine crankshafts, small automobile crankshafts, etc. 6

Metal-Cutting Tools

HAYNES STELLITE CO., Kokomo, Ind. Folder entitled "Haynes Stellite-2400 Metal Cutting Tools," describing this new high-production metal-cutting alloy and listing available sizes and styles of standard square and rectangular tool bits and welded-tip tools. It also lists grinding wheels suitable for sharpening these tools. 7

Pantograph Machines

GEORGE GORTON MACHINE CO., 1109 Thirteenth St., Racine, Wis. Instruction Book and Parts Catalog, covering all pantograph machines made by the company and giving minute directions for unpacking, erecting, lubricating, adjusting, and operating the various types, together with complete information on the cutters used. 8

Gears

FARREL-BIRMINGHAM CO., INC., 377 Vulcan St., Buffalo, New York. Catalogue No. 438, entitled "Farrel-Sykes Gears and Gear Units," illustrating and describing the complete line of speed reducers, high-ratio gear drives, couplings, gears, gear units, and gear generators made by the company. Important tabulated information is included. 9

Threading Machines

LANDIS MACHINE CO., INC., Waynesboro, Pa. Folder announcing the Landmaco quadruple-head threading machine designed especially to handle the maintenance and production threading operations in railroad shops. The folder also illustrates and describes the Landis Reverse Taper heads. 10

Welding Electrodes

HARNISCHFEGER CORPORATION, 4536 W. National Ave., Milwaukee, Wis. Bulletin R-5, giving complete information on each of the company's many types of Smootharc welding electrodes, including procedure directions and other data, making it an informative reference book for welders. 11

Steel

JOSEPH T. RYERSON & SON, INC., 16th and Rockwell Sts., Chicago, Ill. Bulletin entitled "Rycrome Nikrome 'M'," giving comprehensive data on the physical properties of these heat-treated alloy steels which are used for a great variety of heavy-duty applications. 12

Vibration Control

KORFUND CO., INC., 48-15—32nd Place, Long Island City, N. Y. Booklet entitled "Theory of Vibration Control," as presented by S. Rosenzweig, president of the company, be-

fore the June meeting of the American Society of Mechanical Engineers at Dallas, Texas. 13

Furnaces

SURFACE COMBUSTION CORPORATION, Toledo, Ohio. Bulletin SC-78, "Controlled Atmosphere Annealing Furnaces for Non-Ferrous Metals"; Bulletin SC-80, "Horizontal Gas-Fired Radiant Tube Heating Elements as Applied to Every Phase of Heat-Treating." 14

Power Presses and Shears

NIAGARA MACHINE & TOOL WORKS, 637-697 Northland Ave., Buffalo, N. Y. Folder entitled "Pictorial News of Industries with Niagara Machines," illustrating numerous applications of Niagara presses, shears, and sheet-metal-working machines. 15

Electric Furnaces

AJAX ELECTRIC CO., INC., Frankford Ave. and Allen St., Philadelphia, Pa. Bulletin No. 105, illustrating and describing the Ajax-Hultgren electric salt-bath furnace for carburizing, cyaniding, reheating, hardening, tempering, and annealing. 16

Electric Motors

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin GEA-2714, "Wound-Rotor Alternating-Current Crane Motors"; GEA-1542C, "Direct-Current Motors"; and GEA-2571B, "Reconditioning Flooded Electric Equipment." 17

Hobbing Machines

BARBER-COLMAN CO., Rockford, Ill. Circular illustrating and describing the company's Type D hydraulic hobbing machine for accurate heavy-duty high-production manufacturing. Thirty-one features and advantages are listed. 18

Grinding Wheels

ABRASIVE CO., DIVISION OF SIMONDS SAW & STEEL CO., Tacony and Fraley Sts., Philadelphia, Pa. Folder entitled "Red Streak Flanges," illustrating and describing improvement made in high-speed foundry snagging wheels. 19

Free-Cutting Steel

INLAND STEEL CO., 38 S. Dearborn St., Chicago, Ill. Bulletin No. 50, announcing Inland "Ledloy," a new lead-bearing open-hearth free-cutting steel which provides for greatly improved machineability and increased tool life. 20

Corrosion Prevention

MUTUAL CHEMICAL CO. OF AMERICA, 270 Madison Ave., New York City. Booklet entitled "Chromium Chemicals as Corrosion Inhibitors," briefly summarizing studies on the solution of corrosion problems. 21

Heat-Treating Equipment

LEEDS & NORTHRUP CO., 4921 Stenton Ave., Philadelphia, Pa. Folder entitled "To Watch the Tiny Changes that Micromax Can Feel—You'd Need a Glass!," dealing with Micromax electric temperature control. 22

Tungsten-Carbide Tools

TUNGSTEN CARBIDE TOOL CO., DIVISION OF MICHIGAN TOOL CO., 7171 E. McNichols Road, Detroit, Mich. Catalogue of standard tungsten-carbide and tantalum-carbide tips and tipped tools and lathe centers. 23

Belting

MANHATTAN RUBBER MFG. DIVISION OF RAYBESTOS-MANHATTAN, INC., Passaic, N. J. Bulletin No. 6869, describing the construction and applications of six styles of Condor whipcord endless belting. 24

Testing Machine Equipment

BALDWIN - SOUTHWARK CORPORATION, Philadelphia, Pa. Bulletin No. 140, entitled "Recording and Control Equipment," describing devices used in connection with tensile strength testing machines. 25

Springs and Wire Forms

HUNTER PRESSED STEEL CO., Lansdale, Pa. Booklet describing the company's designing and production facilities for springs of all types, sizes, and metals. 26

To Obtain Copies of New Trade Literature

listed on pages 796-798 (without charge or obligation) mark with X in squares below, the publications wanted, using the identifying numbers at the end of each descriptive paragraph; detach and mail to:

MACHINERY, 148 Lafayette St., New York, N. Y.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42

Name ..... *Position or Title* .....

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Pneumatic Riveters

HANNIFIN MFG. CO., 621-631 S. Kolmar Ave., Chicago, Ill. Bulletin No. 43 entitled "Allen Portable and Stationary Pneumatic Riveters," illustrating and describing the various types made. 27

Grinding Machines

CINCINNATI GRINDERS, INC., Cincinnati, Ohio. Bulletin No. G-414, illustrating, describing, and giving specifications covering Cincinnati 12- and 16-inch universal grinding machines. 28

Gear Reducers

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin GEA-1437C, illustrating and describing gear-motors from 1/8 to 75 horsepower, with output-shaft speeds from 6 to 600 revolutions per minute. 29

Drill Heads and Tapping Attachments

GRAY HUB CO., 17265 Gable Ave., Detroit, Mich. Bulletin describing multiple-spindle drill heads, tapping attachments, index tables, and sheet-metal cleaning and oiling machines. 30

Industrial Trucks and Tractors

BAKER INDUSTRIAL TRUCK DIVISION OF THE BAKER-RAULANG CO., Cleveland, Ohio. General catalogue No. 50, illustrating and describing industrial trucks and tractors. 31

Electric Equipment

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa. Bulletin entitled "Instrument Transformers," illustrating and describing different types of small transformer equipment. 32

Hardening Machine

AMERICAN GAS FURNACE CO., Elizabeth, N. J. Bulletin illustrating and describing the company's No. 166-BC continuous clean-hardening machine with reciprocating full muffle. 33

Cold-Drawn Bars

WYCKOFF DRAWN STEEL CO., Pittsburgh, Pa. Folder describing Wyco "Ledloy" cold-drawn bars, a new development in cold-drawn steel for obtaining maximum machineability. 34

Ball Bearings

MARLIN-ROCKWELL CORPORATION, Jamestown, N. Y. Bulletin No. 22 on "How to Adjust the Preload of Duplex Bearings," giving complete engineering information. 35

Lifting Magnets

DINGS MAGNETIC SEPARATOR CO., Milwaukee, Wis. Catalogue No. 22, entitled "The Economical Method for Metal Handling—High Intensity Lifting Magnets." 36

Shop Trucks and Cranes

ELWELL-PARKER ELECTRIC CO., Cleveland, Ohio. Catalogue illustrating and describing the leading types and models of trucks, tractors, and cranes manufactured by the company. 37

Electric Motors

HARNISCHFEGER CORPORATION, 4536 W. National Ave., Milwaukee, Wis. Bulletin M-2, covering convertible slip-ring motors of the standard wound-rotor type. 38

Pillow Blocks

SHAFER BEARING CORPORATION, 35 E. Wacker Drive, Chicago, Ill. Bulletin No. 521, covering "Super-Sealed" roller-bearing pillow blocks. 39

Lathes

ATLAS PRESS CO., Kalamazoo, Mich. Catalogue No. 29, illustrating and describing two new small Atlas back-geared screw-cutting lathes which swing up to 6 inches. 40

Forging Presses

AJAX MFG. CO., Cleveland, Ohio. Bulletin 75, illustrating and describing Ajax solid-frame forging presses with capacities ranging from 500 to 2000 tons 41

Rustproofing

PARKER RUST-PROOF CO., Detroit, Mich. Booklet entitled "A New Finishing System for Iron and Steel Products Increases Finish Durability." 42

To Obtain Additional Information on Shop Equipment

Which of the new or improved equipment described on page 799 and following is likely to prove advantageous in your shop? To obtain additional information or catalogues about such equipment mark with X in the squares below, the identifying number found at the end of each description on page 799 and following—or write directly to the manufacturer mentioning machine as described in July MACHINERY.

51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Fill in your name and address on other side of this blank.

To Obtain Additional Information on Materials of Industry

To obtain additional information about any of the materials described on pages 792-793 mark with X in the squares below, the identifying number found at end of each description on pages 792-793—or write directly to the manufacturer, mentioning name of material as described in July MACHINERY.

201	202	203	204

Fill in your name and address on other side of this blank.

Detach and mail to MACHINERY, 148 Lafayette St., New York, N. Y.

[SEE OTHER SIDE]

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material-Handling Appliances Recently Placed on the Market

W. F. & John Barnes Vertical Machine for Boring Aircraft Engine Blocks

Boring, counterboring, chamfering, and back-chamfering cuts are taken on aluminum six-cylinder in-line aircraft engine blocks by a heavy-duty vertical boring machine recently built by the W. F. & John Barnes Co., Rockford, Ill. The machine is shown in Fig. 1 and two of the engine blocks, in Fig. 2.

The column of the machine is made with one V-way and one flat way to insure accurate movements of a heavy-duty six-spindle head. A Barnes hydraulic unit provides two rates of feed for the head. Each engine block is located in the fixture by registering dowel-pins in holes in the upper surface of the block, and the block is then clamped against this upper surface by means of six cam-operated plungers.

The normal operating cycle of the machine consists of a rapid approach to the work, stop, first feed for boring, second feed for counterboring, stop, back-chamfering feed, and rapid return to neutral. At the end of the back-chamfering cuts, the spindles are automatically indexed to line up all tool bits in a predetermined position before the hydraulic head moves into the neutral position.

The work fixture and all controls of the machine are interlocked to guard against damage to the work or to the tools in case of improper operation. The spindle head cannot feed downward unless the engine block is in the proper rough-locating position of the fixture. Also, the

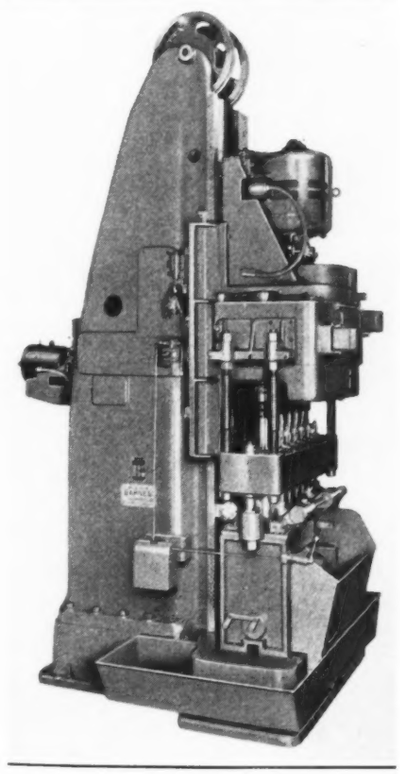


Fig. 1. (Left) Machine Built by the W. F. & John Barnes Co. for Operations on In-line Cylinder Blocks for Aircraft Engines

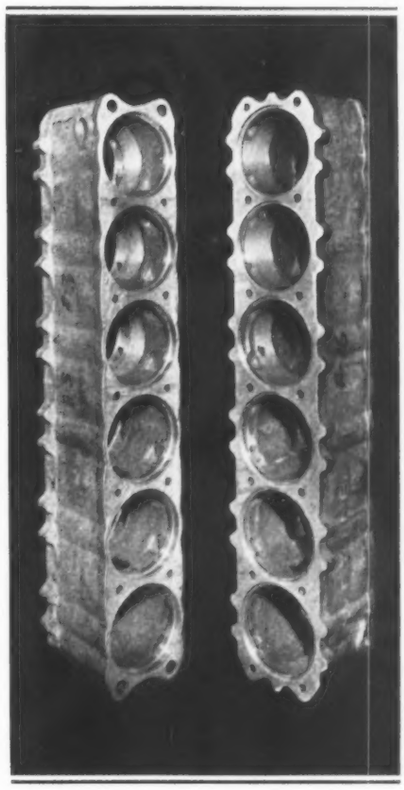


Fig. 2. (Right) Engine Blocks Bored, Counterbored, Chamfered, and Back-chamfered by the Machine Illustrated in Fig. 1

To obtain additional information on equipment described on this page, see lower part of page 798.

head cannot feed downward unless the fixture plate and the engine block are both located over the dowels and clamped, and the plunger shaft is in its proper position. The boring-bars are equipped with tungsten-carbide tool bits. The estimated production of this machine is twenty engine blocks an hour. 51

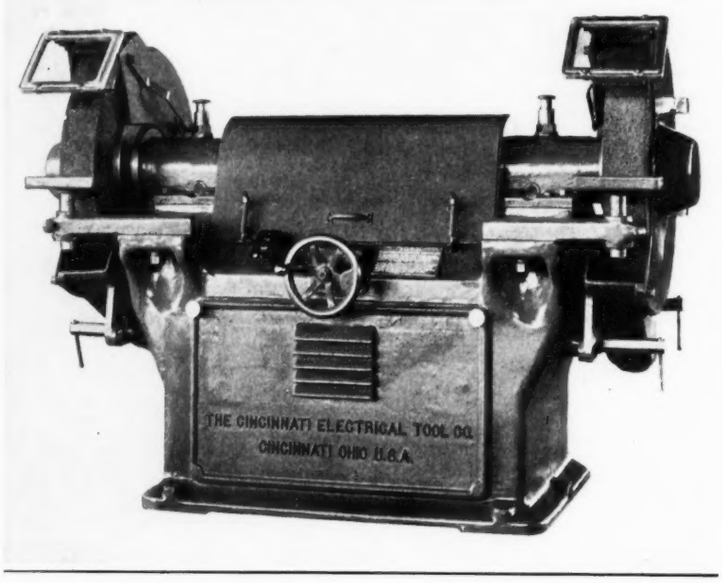
"Cincinnati Electrical" Variable-Speed Snagging Grinder

A variable-speed snagging grinder which can be furnished for using either high-speed or vitrified grinding wheels and which enables the correct peripheral speed to be used during the entire life of the wheels, has been placed on the market by the Cincinnati Electrical Tool Co., Division of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. The speed of this grinder is increased to compensate for wheel wear by merely turning a handwheel on the front of the pedestal as far to the right as the spark shields will permit, without striking the grinding wheels.

The speed change is effected through two adjustable-pitch sheaves, one of which is mounted on the motor shaft and the other on a countershaft within the pedestal of the machine. As the adjustment of the pitch diameters of these pulleys is synchronized with the movement of the wheel guards and spark breakers, and as the wheel guards move as one unit, it is impossible to "over speed" the wheels. Adjustments are made with the motor running.

Compensation for belt stretch or belt renewal is made through two hinged and threaded studs on the countershaft assembly. A shaft-locking device facilitates changing of the grinding wheels. Oil gages on the bearing boxes and countershaft assembly indicate the oil level. Drain plugs facilitate the changing of oil.

This grinder may be supplied for wheels up to 30 inches in diameter driven by motors up to 15 horsepower. Although the machine is now being introduced on the market, it has been in actual operation for over a year and has given unusually satisfactory performance records. 52



Snagging Grinder Made by the Cincinnati Electrical Tool Co. with Constant Wheel-speed Feature

Hydro-Power Injection Molding Press—A Correction

In the description of the Model 100 H-P-M Hydro-Power injection molding press, built by the Hydraulic Press Mfg. Co., published in the May number, page 633, MACHINERY regrets the presence of an error in the publication of the first paragraph, which should have read as follows:

"To meet the demand for larger capacity for the injection molding of thermo-plastics, the Hydraulic Press Mfg. Co., Mount Gilead, Ohio, has recently introduced the Model 100 H-P-M Hydro-Power injection molding press. This machine has a clamping pressure of 100 tons; a maximum projected mold cavity of from 30 to 60 square inches, depending on the shape and type of the piece to be molded; a plasticizing capacity of approximately from 80 to 100 pounds per hour; and an operating speed of two complete cycles per minute. The clamping portion of the Model 100 machine is practically the same as on the company's Fastraverse presses ordinarily used for molding thermo-setting materials, such as Bakelite. The machine may, therefore, also be used for this class of molding without change. The injection units are rendered inoperative by simply opening a switch." 53

Houghton Soluble Cutting Oils

A new series of soluble cutting oils, including Hocut 60, Metcut 60, and Permasol 60, has been announced by E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa. The outstanding features of these oils are: Permanence in solution, that is, they do not break down even under boiling conditions; rust prevention; self-emulsification, permitting immediate mixing in cold solutions; lubricating and coolant qualities which lengthen the life of the tool; freedom from gumming; antiseptic; and absence of volatile materials. 54

To obtain additional information on equipment described on this page, see lower part of page 798.

Cincinnati-Bickford 2 1/2-Foot High-Speed Radial Drilling Machine

A 2 1/2-foot high-speed radial drilling machine with a 7 1/2-inch diameter column has been added to the Super Service line of the Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio. This machine was developed especially for plants in which the work includes much small drilling and tapping of fairly large parts. The machine is therefore adaptable to production lines in plants engaged in the manufacture of automobiles, airplanes, agricultural machines, military equipment, business machines, and so on.

Three changes of spindle speed are obtained through the upper lever on the left-hand side of the head with either an alternating- or direct-current motor running at 1200 revolutions per minute. The speeds can be in any of several ranges, and the ranges can be changed by merely replacing two pick-off gears. Six spindle speeds can be obtained by employing a two-speed alternating-current motor which is controlled by a fast-slow-stop switch on the right-hand side of the head.

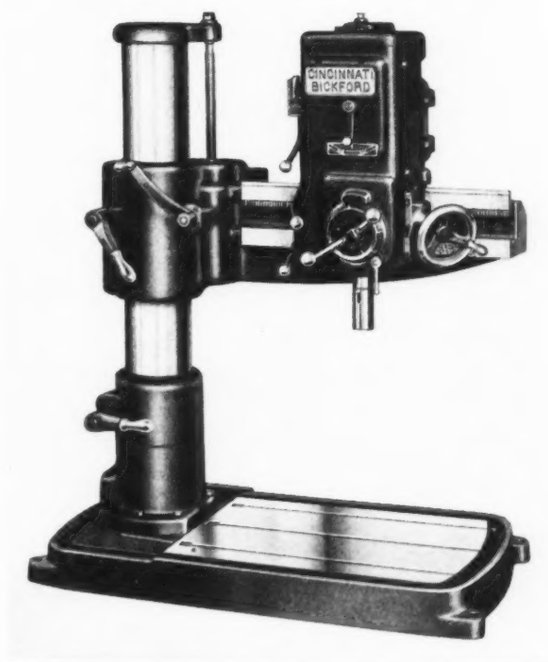
Three rates of power feed, 0.003, 0.006 and 0.009 inch can be instantly selected through an indicator lever in the center of the head. The all-geared feed-change unit is equipped with anti-friction bearings and is automatically oiled. The feed case is an aluminum-alloy casting so as to keep the weight of the head at a minimum.

The power feed is engaged through the quick-return levers located directly above the spindle and which are also used for hand feeding. The feed clutch is of the adjustable expanding ring type. Its automatic disengagement point is determined by setting a graduated dial at the predetermined depth and clamping it in position through a lever.

The spindle control lever for forward rotation, stopping, and reverse rotation is located on the lower left-hand side of the head. It operates built-in push-buttons that control a 1-horsepower totally enclosed reversing motor. The head is mounted on ball-bearing rollers and a hardened steel armway. It is moved 3 inches per turn of the handwheel and is clamped to the arm by operating the central lever on the left side of the head. The arm and column are clamped through levers on the column. A constant-speed rotary pump automatically lubricates every moving part of the head. 55

Cimatool Gear-Burring Machine

Gear teeth can be burred at speeds up to 800 teeth a minute by a 2-B machine now being introduced on the market by the Cimatool Co., E. Third and June Sts., Dayton, Ohio. By employing a fly cutter on each of two cutter-spindles, this machine will burr both sides of teeth on gears up to 8 inches in outside diameter. Other machine models are available for larger gears.



Cincinnati-Bickford Small-sized Radial Drilling Machine for Production Work

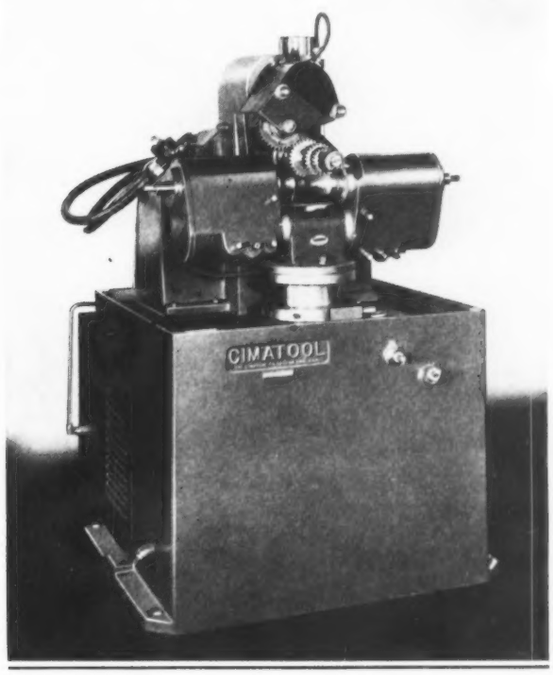


Fig. 1. Cimatool Machine for Burring the Teeth of Gears up to 8 Inches in Outside Diameter

To obtain additional information on equipment described on this page, see lower part of page 798.

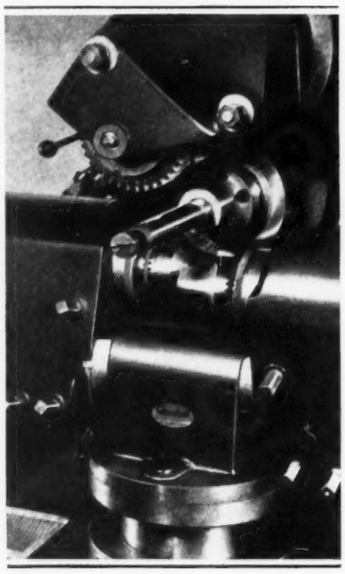


Fig. 2. Close-up View Showing the Two Fly-cutter Spindles

The cutter-spindles are mounted horizontally and opposed to each other, as shown in Fig. 2. They may be adjusted 1 1/2 inches laterally toward and away from each other and through a 60-degree arc from front to back so as to accommodate practically any gear tooth face within the capacity of the machine. There is a quick-change timing adjustment on each cutter-spindle which enables adjustments as fine as 1/600 of a turn.

The work-gear indexing idler swings upward and to the left to accommodate different sizes of gears. This idler is synchronized with the cutter-spindles so that the machine cannot get out of proper timing. Another feature is an automatic cycle control which stops the spindles in such a position that the work can be loaded and unloaded without interference with the cutters or the necessity of positioning them manually. Timken tapered roller bearings are provided throughout the machine and pressure lubrication is supplied to all bearings. Clamping of the work is optional. 56

Sebastian Stremeline Geared-Head Lathes

Stremeline Type H geared-head lathes in which all shafts in the headstock, including the spindle, are equipped with Timken bearings, have been placed on the market by the Sebastian Lathe Co., Cincinnati, Ohio, in five sizes ranging from 12 to 20 inches in nominal swing. These lathes are obtainable with bed lengths ranging from 3 to 24 feet.

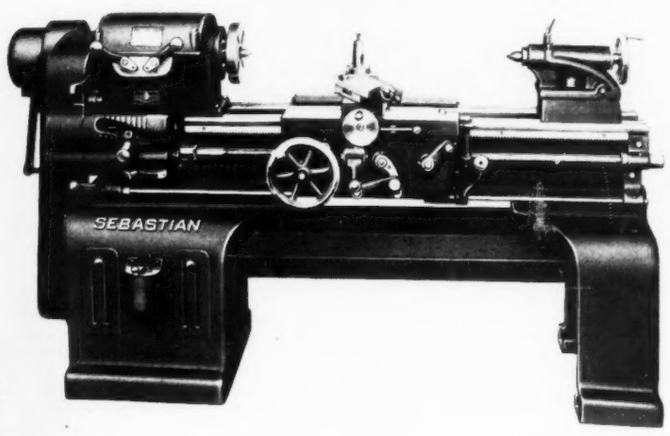
The threads on the cross-feed screw, and the threads and spline on the lead-screw of all lathes up to 10 feet in length, are chrome-hardened, to resist wear, and thus insure accuracy over a long period of time. The tailstock spindle is also chrome-hardened for maximum wear resistance. Knobs, handles, and other control devices are chromium-plated to eliminate rust and improve appearance. The spline of the lead-screw is milled below the bottom of the threads so that the keys in the apron bevel gears do not touch the threads.

These lathes are made without a feed-rod, thereby permitting the use of a larger lead-screw and a larger apron, as well as simplifying the design of the machine. 57

Cutler-Hammer Heavy-Duty Controllers

A new line of direct-current heavy-duty controllers for all machine tool applications, for heavy-duty applications below 10 horsepower, and general-purpose use above 10 horsepower, is announced by Cutler-Hammer, Inc., 264 N. 12th St., Milwaukee, Wis. A new timing device that operates magnetically provides positive and definite time acceleration which is unaffected by load, temperature, or other working conditions. Once adjusted, this controller will maintain the starting time period accurately.

Constructional features include a new style case, snap-on type cover which can be completely removed for installation and wiring, and a tilting panel frame which allows quick access to the rear of the panel. These controllers conform to the new N.E.M.A. standards for machine tool and general-purpose service and include non-reversing and reversing types, with and without dynamic braking, for both constant-speed and adjustable-speed motors. They are available for use with either push-button or drum type master switches and in all standard N.E.M.A. ratings up to 75 horsepower, 115 volts, and 150 horsepower, 230 and 550 volts. 58



Stremeline Lathe with "All-Timken" Headstock and Chrome-hardened Lead and Cross-feed Screws

To obtain additional information on equipment described on this page, see lower part of page 798.

Barber-Colman Hydraulic Hobbing Machine

A Type D hydraulically actuated hobbing machine designed especially for heavy-duty, high-production manufacture, is the latest development of the Barber-Colman Co., Rockford, Ill. The hydraulic operation includes the lowering of the work-slide to a positive stop, hydraulic clamping of the work-slide at five points, feeding of the hob slide, elevation of the work to clear the hob, quick return of the hob slide, and stopping of the machine. The hydraulic cycle can be interrupted at any point, if desired, by simply moving a lever. The work-slide is then unclamped and raised to clear the hob and the hob slide is returned to its starting position.

The hydraulic feed rate of the hob is indicated by a large dial. Any rate of feed from zero up to 2 inches per minute is obtainable at any time by simply adjusting this dial. The hydraulic equipment provides for left-to-right climb cutting or conventional hobbing by making simple adjustments on the control panel. Reversal of the feeding direction makes a corresponding change in the rapid traverse. Inching of the hob slide and hydraulic traversing to the right or left in setting up the machine may be obtained through a lever that is operative only when the work is clear of the hob.

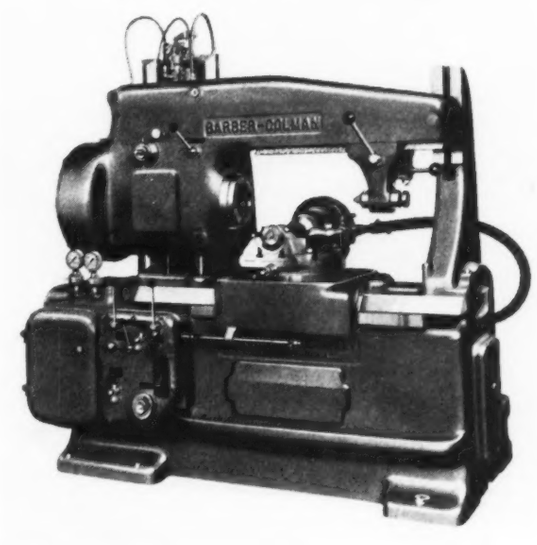
The depth of cut is accurately controlled by means of two hardened stops, one of which is in a fixed position, while the other is provided with a micrometer adjustment. Both stops are protected by a telescopic guard. Other features of the machine include direct-reading gages which indicate the clamping and feeding pressures of the hydraulic circuit, and thus provide a continuous check on satisfactory operation of the machine.

The machine has a capacity for cutting gears up to a maximum diameter of 14 inches, a maximum face width of 14 inches, and with teeth up to 3 diametral pitch, in steel. The maximum travel of the hob slide is 15 inches; the maximum distance from the center line of the work-spindle to the center line of the hob spindle, 9 3/4 inches; and the maximum hob diameter 5 1/2 inches. 59

Hannifin "Hy-Power" Hydraulic Press

A general utility type "Hy-Power" press available in capacities from 12 1/2 to 60 tons, for pressing, forming, crimping, stamping, shallow drawing, and similar operations has been brought out by the Hannifin Mfg. Co., 621-631 S. Kolmar Ave., Chicago, Ill. This high-speed, semi-automatic hydraulic press is a compact, self-contained unit. The press shown in the accompanying illustration has a capacity of 12 1/2 tons and the complete operating cycle is approximately 2 seconds.

Hydraulic operation of this press provides an automatically completed press cycle when a push-button on the controlling unit is pressed. This cycle includes: Rapid advance stroke until the die touches the work; automatic high-pressure working stroke; automatic reversal at maximum pressure; and rapid return to starting position. The hydraulic pressure generator is driven by a 2-horsepower motor in the 12 1/2-ton press and is located in the base of the machine. The pressure generator



Hydraulically Actuated Hobbing Machine Recently Brought out by the Barber-Colman Co.

Hannifin "Hy-Power" Hydraulic Press Built in Capacities from 12 1/2 to 60 Tons

To obtain additional information on equipment described on this page, see lower part of page 798.

unit is mounted on casters and may be easily removed.

Operation is controlled by two push-buttons at the sides of the table. Since both push-buttons must be held down to operate the press, the operator's hands are fully protected. Pushing both buttons causes the ram to operate through one cycle only. Releasing either control button at any point of the cycle stops the ram and causes it to return to the top position. The press will not repeat if the push-buttons are held down. 60

Watson-Stillman Injection Molding Machine and Hydraulic Pressure Pump

The Watson-Stillman Co., Roselle, N. J., has recently brought out a hydraulic automatic injection molding machine in which improvements have been incorporated to insure faster operation and increased production. This machine is a complete self-contained unit arranged for manual, semi-automatic, or full automatic operation. With a 24-inch maximum opening between the die-plates and an adjustment of 18 inches on the clamping end, the minimum die thickness is 6 inches.

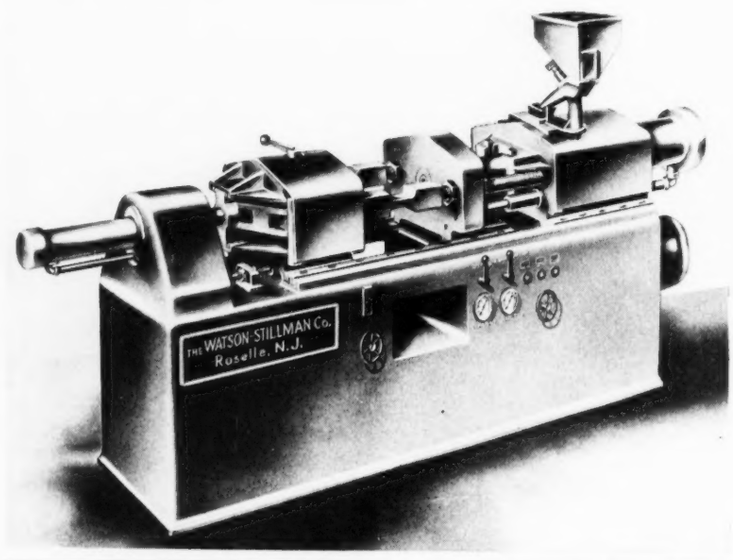
Dies having up to 50 square inches projected area are held in the closed position by a patented clamping device without transmitting strains to other parts of the machine. Adjustment of the nozzle end each time that dies are changed is not necessary. The capacity of the hopper is 25 pounds and the molding capacity is 0 to 6 ounces. The timing device may be set for from one to six cycles per minute.

The bore of the heating cylinder is smooth and of uniform diameter and affords no place for material to lodge. This is a distinct advantage when changing from material of one color to another. To clean the contact bushing the operator need only move a small lever, which causes the die-plate to move forward, away from the nozzle. The die-plate is automatically returned to and locked in the molding position.

Another improved product recently brought out by this company is a "Uniflo" hydraulic pressure pump. In this pump the successful combination of the "swash-plate" form of operating mechanism with conventional packed plunger and poppet valve features has been accomplished. This arrangement insures compactness, minimum pulsation, enclosed operating parts, and high mechanical efficiency.

The power unit is entirely separate from the hydraulic unit and is fully enclosed. The hydraulic unit is a single-piece steel forging drilled for plungers and valves. The novel arrangement of the passages and valves permits the use of plungers located in a circle with transverse suction and discharge passages extended through the block.

Pumps up to 7 1/2 horsepower are designed with five plungers, while larger sizes are made with seven plungers to insure a uniform discharge. These Uniflo pumps are available in standard sizes from 2 to 100 horsepower for pressures of 1500 pounds per square inch and upward. They will handle oil, water, or any other hydraulic medium. Sizes up to 25 horsepower can be furnished with variable delivery from zero to maximum through the use of a variable-speed transmission. 61



Watson-Stillman Hydraulic Injection Molding Machine

Fansteel Improved Brazing Metal and Flux

For the brazing of dissimilar metals or alloys, especially under conditions where the brazed joint is subject to heavy loads, a new alloy and a companion flux are being marketed by the Fansteel Metallurgical Corporation, North Chicago, Ill., under the trade names "Fanite" and "Fanflux." These products are especially recommended for the brazing of tipped carbide or hard metal-cutting tools.

Fanite is intended for use in a controlled-atmosphere furnace at temperatures from 1950 to 2100 degrees F. and is handled with exactly the same equipment and technique as copper. It is available in standard strips 1 1/2 inches wide by 8 inches long and 0.004 or 0.010 inch thick. The 0.004 inch metal is used as a shim between the surfaces to be united so that the brazing metal

To obtain additional information on equipment described on this page, see lower part of page 798.

is in place when it melts. The 0.010 inch metal is used where it is desired to flow the molten metal into the joint by capillary attraction. 62

Noble & Westbrook Marking Machine

The Noble & Westbrook Mfg. Co., 20 Westbrook St., East Hartford, Conn., has recently developed a heavy-duty rapid-production marking machine designated No. 21-H. This machine is considerably heavier than previous models and has an over-arm support for the dial spindle which makes it possible to mark two roller-bearing rings in one operation.

The holder for the two marking dies has a vertical adjustment, as well as an in-and-out adjustment for controlling the the depth of the impression or for marking rings of different diameters. The work-supporting mandrels are held securely in the carrying dial by means of locknuts, and the bushings over the mandrels are mounted on needle bearings. The depth of the impression made on each ring is approximately 0.020 inch. The production time is about 120 pieces per minute. 63

Landis Pipe Threading and Cutting Machine

A receding-chaser pipe threading and cutting machine, with a capacity for threading pipe from 1 5/8 to 4 3/4 inches in outside diameter, has been added to the line of threading equipment made by the Landis Machine Co., Inc., Waynesboro, Pa. This machine will generate a tapered pipe thread of any length up to and including 5 inches and will cut all tapers regularly used for plain pipe, oil-well casing, etc.

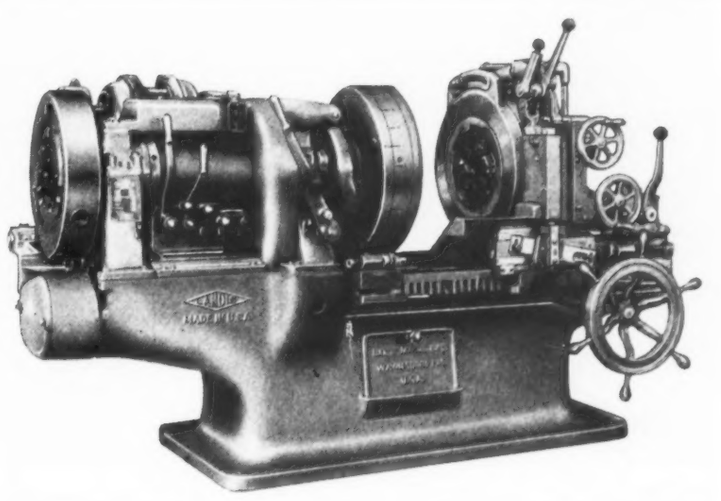
The receding-chaser feature has been developed to reduce the cutting strain on the chasers and thus insure maximum chaser life and accurately tapered threads having a fine finish. It also permits very narrow chasers to be used. The die-head is accurately graduated for all pipe sizes within its capacity and is equipped for taking both roughing and finishing cuts without any diametrical adjustment. The chaser-holders can be adjusted independently toward or away from the center of rotation to insure equal distribution of the cut.

The taper generated on this machine is controlled by a sine bar which can be quickly and easily adjusted for all tapers. The forward travel of the die-head is controlled by a lead-screw located centrally between the guides of the machine. The lead-screw has a coarse-pitch thread with a rounded crest which facilitates the engagement of the nut and insures maximum life. When one end of the lead-screw becomes worn, it can be reversed to permit use of the opposite end.

As the die-head advances on the pipe, the sine bar engages a retarding bracket on the side of the machine, thus actuating the taper mechanism. Since the length of the pipe extending in front of the chuck may not be constant, unless a work-stop is employed, the sine-bar retarding bracket is designed to be adjusted quickly to any desired location. An automatic safety device releases the sine-bar retarding bracket in the event that the operator neglects to open the die-head on finishing the thread. The lead-screw nut is released automatically at the end of the cut. A central reservoir located on top of the carriage lubricates the lead-screw automatically.

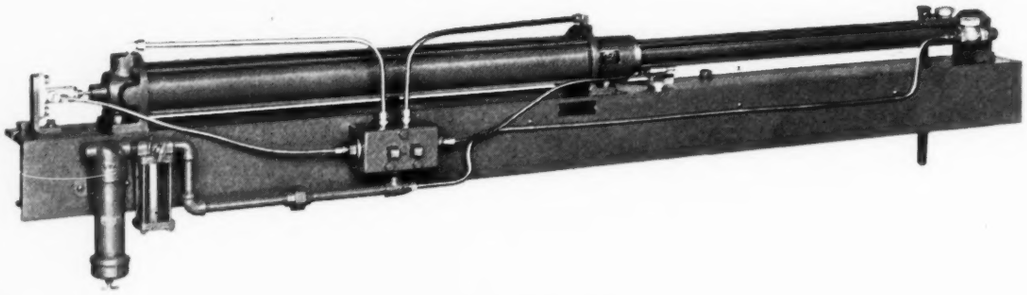
A pitch indicator assists the operator in correctly engaging the lead-screw nut when a second or finishing cut is taken. Various feeding speeds are obtainable by means of change-gears that are housed in a gear-box on the head-stock end. 64

Noble & Westbrook Marking Machine



Landis Receding-chaser Pipe Threading and Cutting Machine

To obtain additional information on equipment described on this page, see lower part of page 798.



Equipment Built by the Tomkins-Johnson Co. for Increasing the Pressure in Compressed Air Lines

Tomkins-Johnson Compressed Air Booster

Equipment known as a compressed air booster has been developed by the Tomkins-Johnson Co., Jackson, Mich., for increasing air-line pressure to predetermined amounts. The particular unit illustrated raises air from a pressure of 80 pounds per square inch to a pressure of 400 pounds per square inch. The equipment is based on the use of a 3-inch diameter cylinder in conjunction with a cylinder 1 1/8 inches in diameter. Compressed air at a pressure of 400 pounds per square inch is developed with each stroke of the pistons. The stroke is 30 inches.

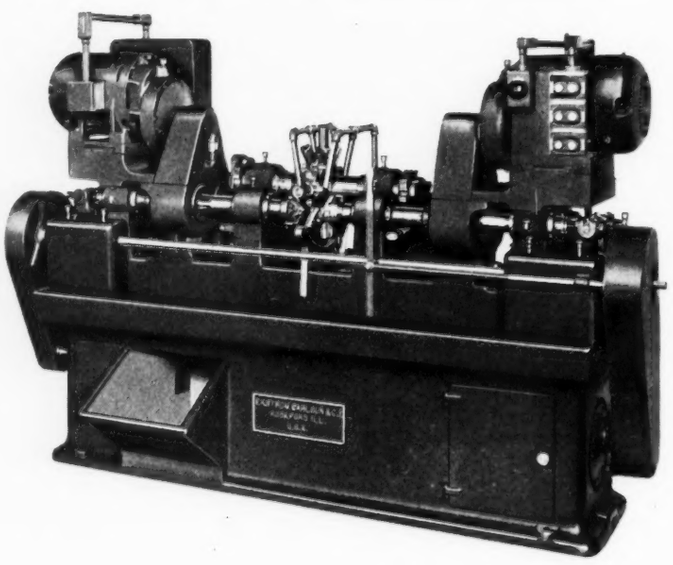
The compressed air from this unit is piped to a tank, from which it is used in testing airplane strut cylinders. The unit incorporates the use of the T-J remote-control valve system. The action of the piston in the larger cylinder operates buttons at both ends of the stroke to effect the reciprocating motion. 65

Automatic Turning or Hollow-Milling Machine

A four-spindle automatic turning machine designed for the economical hollow-milling or turning of universal-joint yokes or work of a similar nature has been brought out by Ekstrom, Carlson & Co., Rockford, Ill. This machine is equipped with two spindles and two heads for rough-turning and two spindles with heads for finish-turning. With this arrangement both ends of the universal-joint yoke can be completely finish-turned in one pass through the machine. The production rate in rough- and finish-turning universal-joint yokes is 204 pieces per hour.

Two geared-head motors of 5-horsepower capacity are used for driving the four spindles and one geared-head motor of 2-horsepower capacity is used for driving the feed mechanism and the lubricating pump. The two geared-head motors are fitted with sprockets and silent chains for driving the four spindles. Inside of the column is mounted the geared-head, 2-horsepower motor which is fitted with a sprocket and chain for feeding the cutter-heads to the work.

One set of four cutter-heads is supplied as standard equipment with each machine and an extra set of heads can be supplied, which eliminates loss of time in grinding and setting the tools. The tools are flooded with cutting compound supplied by the heavy-duty pump.



Ekstrom, Carlson & Co.'s Automatic Turning Machine

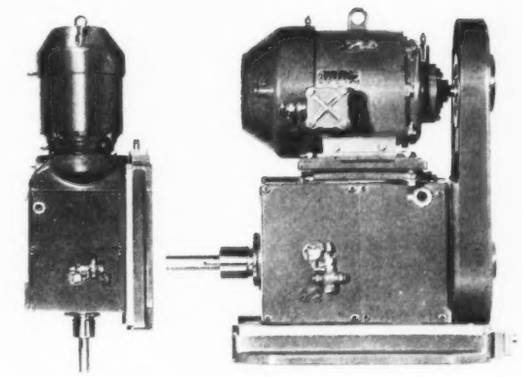
To obtain additional information on equipment described on this page, see lower part of page 798.

The eight-station indexing head and locking mechanism are operated from the feed motor and are timed accurately to allow the four spindles to complete the operation and return before the cycle is repeated. One set of splined arbors and a set of four centers located inside of the cutter-heads for accurately centering the work, are standard equipment. 66

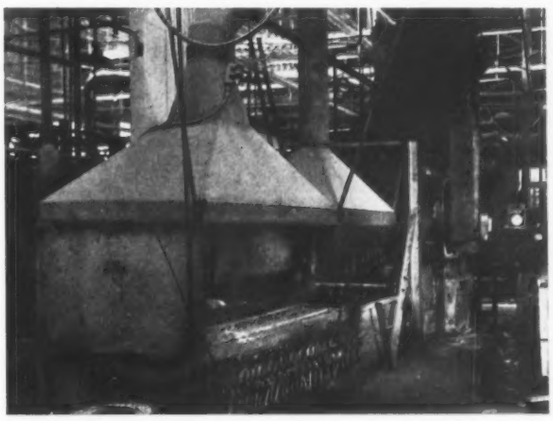
Kingsbury Drilling and Tapping Units

Four new automatic positive-feed units designed for performing such operations as drilling, tapping, reaming, spot-facing, counterboring, light milling, etc., have been added to the line of automatic drilling head units and may be mounted at any angle for use either singly or in groups and for performing a multiplicity of machining operations. Although adapted for continuous use on one set-up, the feeds, speeds, and length of stroke can easily and quickly be changed to accommodate different jobs. Milling attachments may also be applied when desired.

Multiple-spindle heads may be mounted on the quill for various jobs. The capacities of the units vary according to the material being machined. The Model 12 unit, for example, will drill one 11/16-inch hole at the rate of 60 feet a minute in a steel forging or five 1/4-inch holes. The Model 22 unit will drill one 1-inch hole at the rate of 60 feet per minute in a steel forging or eight 1/4-inch holes. 67



Kingsbury Vertical and Horizontal Drilling and Tapping Units



Ajax-Hultgren Furnace Used for Liquid Carburizing Steering-gear Parts

made by the Kingsbury Machine Tool Corporation, Keene, N. H. The four new units, Models 12, 13, 22, and 23, are almost identical in mechanical construction. Models 22 and 23, however, have greater capacities and are of heavier construction. They are designed with a cam feed that insures accurate repetition of the work cycle.

Models 12 and 13 have a maximum stroke of 2 1/2 inches. These units are furnished with motors from 1 to 2 horsepower, according to requirements. Models 22 and 23 have a maximum stroke of 3 1/2 inches and are equipped with motors from 2 to 3 horsepower. All tapping units are furnished with reversing motors.

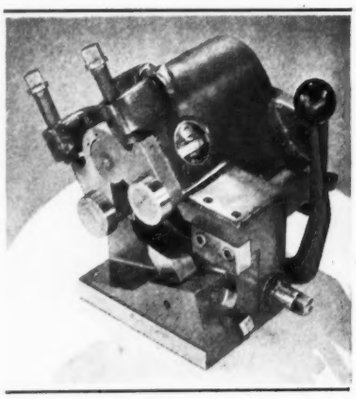
The units are self-contained

Ajax-Hultgren Electrically Heated Salt-Bath Furnace

An electrically heated salt-bath furnace, in which electrodes are employed to generate heat, has been developed by the Ajax Electric Co., Inc., 957 Frankford Ave., Philadelphia, Pa. In operation, a pair of metal electrodes is immersed in the salt, through which an alternating current is passed. The salt is thus heated by direct resistance. The electrodes are located close to each other on one side of the tank so that the working space is kept clear.

Uniform heating is obtained by the patented arrangement of the electrodes in the bath, which utilizes electromagnetic force to provide an automatic stirring action throughout the entire bath. Furnaces are now in use with nitrate baths for hardening aluminum alloys and for tempering steel parts at temperatures up to 1100 degrees F., annealing nonferrous metals at temperatures up to 1500 degrees F., cyaniding and liquid carburizing steel parts at temperatures between 1500 and 1700 degrees F., and hardening high-speed steel tools at temperatures up to 2350 degrees F. Fully mechanized units are in use which have a continuous conveyor that automatically transfers the work to the bath and through subsequent operations such as quenching, degreasing, washing, etc. 68

To obtain additional information on equipment described on this page, see lower part of page 798.



Single-cutter Bar Turner for High-speed Cuts

Gisholt Single-Cutter Bar Turner for Turret Lathes

A single-cutter bar turner for use on Nos. 3, 4, and 5 ram type universal turret lathes and Nos. 1L, 2L, and 3L high-production turret lathes, is announced by the Gisholt Machine Co., 1209 E. Washington Ave., Madison, Wis. This turner is rigidly constructed for taking high-speed cuts on bar work. The tool can be quickly set to center above the marked reference ledge. A graduated micrometer screw is provided for setting to exact diameters. The roller bracket is equipped with rollers that are held against the adjusting screws by spring tension to facilitate setting. The rollers can be adjusted to lead or to follow the cutter without sacrificing rigidity. When set to follow the tool, they burnish the work to a high finish. The cam spring is incorporated in the toolslide and maintains a constant pressure between the tool-holder and micrometer screw for any setting.

The cutting-tool slot will take high-speed tools or cemented-carbide tools having large shanks. One wrench is used for setting the cutter and for adjusting and clamping the rollers. The operating lever retracts the tool 1/32 inch when backing off to prevent marring the work. 69

Continental Band Filer

A band filing machine of the construction illustrated has just been placed on the market by the Continental Machine Specialties, Inc., 1301 S., Washington Ave., Minneapolis, Minn., manufacturer of Doall combination sawing, filing, and polishing machines. The file band used on the new machine consists of a Swedish spring-steel band on which short segments of files are riveted. When the band flexes over the upper or lower wheel pulley, the file segments open. They close and interlock securely as they leave the upper wheel and thus form a continuous rigid file at the point of the work. A narrow support behind the files enables heavy pressure to be exerted for rapid filing.

The file bands are furnished in various cuts and shapes and in widths of 1/4 and 3/8 inch. There is a Vixen-cut file with large milled teeth, which acts more like a milling or broaching cutter than an ordinary file and

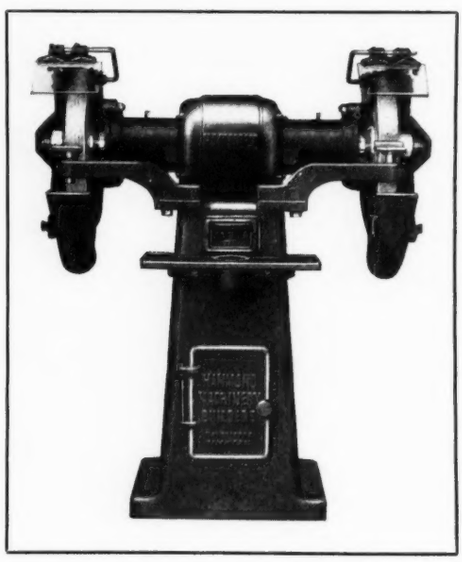
Band Filer Built by the Continental Machine Specialties, Inc.

is intended for dressing brass, aluminum, copper, zinc, etc. The file assortment permits the use of this band filer on high-carbon steel, aluminum, plastics, fiber, wood, and so on.

Different filing speeds are available to suit individual jobs. The 12-inch work-table tilts in two directions for filing work at an angle. The machine is driven by a 1/4-horsepower motor. 70

Hammond Wide Swing Grinders

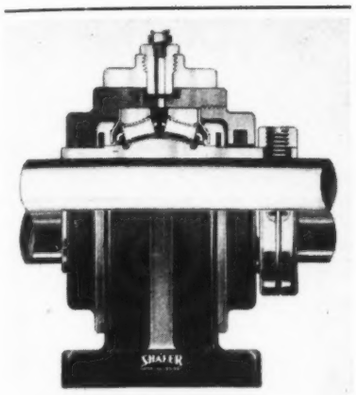
The addition of a new series of wide swing grinders to their line of grinding machines has recently been announced by the Hammond Machinery Builders, Inc., Kalamazoo, Mich. Although the accompanying illustration shows a 2- or 3-horsepower machine, this series includes machines built in sizes up to and including 7 1/2 horsepower. On the 2- and 3-horsepower machines the wheels are spaced 30 inches between centers and the spindle is 41 inches long over all.



Hammond Wide Swing Grinding Machine for Handling Bulky Work

These grinders have been especially designed to provide a maximum amount of space around the wheels to facilitate the handling of bulky or awkward-shaped work. The totally enclosed motor and sealed bearings prevent the entrance of abrasive matter. Shatterproof eye-shields and a magnetic starter with overload and low-voltage protection are supplied. 71

To obtain additional information on equipment described on this page, see lower part of page 798.



"Super Sealed" Pillow Block Made by Shafer Bearing Corporation

Shafer "Super Sealed" Pillow Blocks

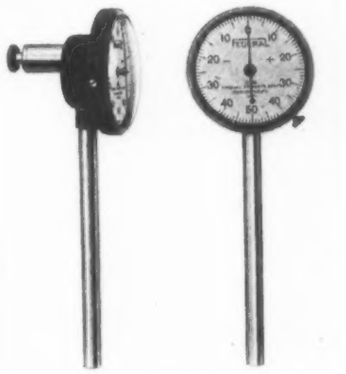
The Shafer Bearing Corporation, 35 E. Wacker Drive, Chicago, Ill., has developed a new line of "super sealed" pillow blocks for heavy-duty service embodying electrically welded steel housing construction. The double-row, self-aligning roller bearing is mounted in a substantial cartridge housing containing the sealing members. This cartridge is then mounted in the welded steel frame. The base is machined and is of the four-bolt type.

The concave roller bearing provides self-alignment and capacity for radial or thrust loads, or combined radial and thrust loads. The double-row bearings have extended inner races. The drive collar is provided with two socket-head setscrews and a spring locking wire, insuring positive locking even under severe vibration or shock loads.

The "super sealed" construction consists of three sealing members: An outer felt of special self-aligning type; inner sealing plates mounted between the covers and bearing, forming a bearing lubricant chamber; and washers pressed on the inner race. These bearings are regularly made in shaft sizes from 1 7/16 to 3 15/16 inches. 72

Federal Indicator of Improved Design

An improved indicator having the contact point arranged perpendicular to the face of the dial to permit it to be used in positions where the regular type cannot be readily employed, has been brought out by the Federal Products Corporation, 1144 Eddy St., Providence, R. I. This indicator, designated as the V-8-1, supersedes the Model 80 Junior. In the new indicator a crown gear is used in place of the previous spiral arrangement for changing the direction of the gear movement. This arrangement is said to give greater sensitivity and a higher degree of accuracy. An "Oilite" bushing is used for the 3/8-inch diameter stem. This type of bushing is employed to lessen friction and provide smoother operation. 73



Federal V-8-1 Indicator Designed for Greater Sensitivity

Heyman Semi-Automatic Feeding Machine for Punch Presses

A machine built for feeding irregularly shaped pieces of material to a punching or forming press has been brought out by the Heyman Mfg. Co., 149 Church St., New York City. This feeding machine was originally developed for use in the mica industry, where it is now extensively employed in punching out parts for radio tubes and condensers from pieces and clippings of mica ordinarily sold as junk or waste material. This machine is equally well adapted for feeding small sheet-metal pieces to presses for punching or forming operations. Large quantities of sheet-metal clippings and scrap stock, ordinarily sold as junk, can thus be used to advantage by employing the feeding machine.

The semi-automatic feeding machine shown in the illustration is attached to a No. 18 Bliss press by means of three studs. It has an indexing table which is intermittently rotated by a pawl and ratchet. The material to be

Heyman Semi-automatic Feeding Machine Applied to a Punch Press

To obtain additional information on equipment described on this page, see lower part of page 798.

punched is held on the table by means of a vacuum which is broken when the piece reaches a position opposite the die. At this point the left-hand arm picks up the material by means of a vacuum and places it on the die. This is done with extreme accuracy, so that a piece of scrap stock of almost the same size as the die can be used.

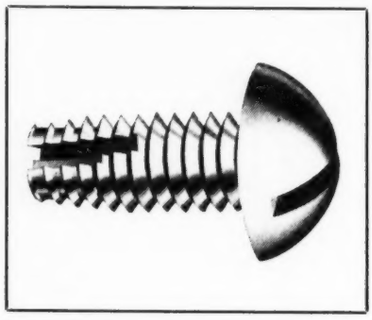
The press is automatically tripped and as the finished product falls from the punch a blast of air blows it into a chute. Another blast of air blows the waste matter to the rear of the press. This is the present practice in producing mica parts, but the right-hand arm can be made with a vacuum arrangement which will pick up the finished product and deposit it at the right of the press. 74

Buffalo Drilling Machine Available in Eighteen Models

A line of drilling machines built specifically to meet the needs of the metal-working industries for moderately priced, accurate, and powerful drilling machines, has been brought out in eighteen models by the Buffalo Forge Co., Buffalo, N. Y. The various models include production table and base types, standard table types, and multiple-spindle types with various feeding arrangements in bench and floor models.

All models have a swing of 18 inches, a capacity for drilling one-inch holes in cast iron, spindle sleeve bearing adjustment, and a 4-inch column. 75

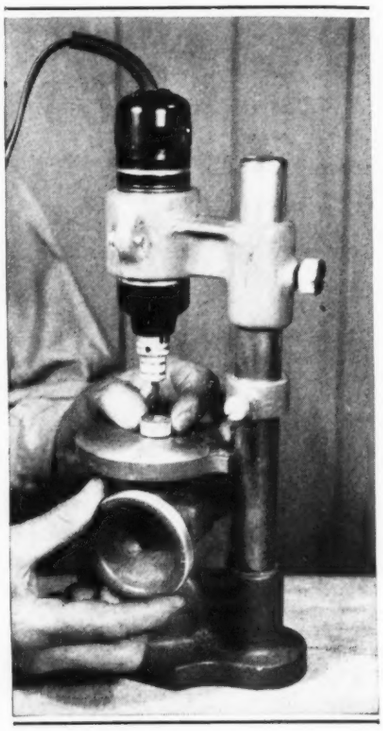
Buffalo Drilling Machine Made in Eighteen Models



Shakeproof Thread-cutting Screw for Plastic Materials

Thread-Cutting Screw for Plastic Materials

A screw that cuts its own thread has been placed on the market by the Shakeproof Lock Washer Co., 2501 N. Keeler Ave., Chicago, Ill., for use expressly with plastic materials. This Hi-Hook thread-cutting screw has a double-width slot, as illustrated, which gives an acute cutting edge that produces a clean sharp thread in both molded and laminated plastic compositions. The construction of the screw reduces the high driving torque normally encountered and thus enables fast, easy driving with minimum breakage. Because the screw cuts a standard thread, it may be replaced, if desired, by a conventional machine screw. 76



Small Sensitive Drill Press Made by Chicago Wheel & Mfg. Co.

Precision Drill Press for Small-Hole Drilling

The Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago, Ill., has recently brought out the small sensitive drill press unit here illustrated, which is designed for the accurate drilling of holes from 1/8 inch in diameter down to the smallest sizes within commercial limits. This unit can be permanently attached to the bench or it can be easily carried to the work. It is powered by the De Luxe Handee drill which has a speed of 25,000 revolutions per minute.

Special drills from 1/8 inch to 1/16 inch in diameter, graduated in sixty-fourths of an inch and mounted on 1/8-inch shanks, are available for use in this drill. The work is fed to the drill point through a sensitive rack and pinion. The power unit can be easily detached and used as a hand tool for grinding, drilling, polishing, and other operations by simply unclamping the holding member mounted on the vertical column. 77

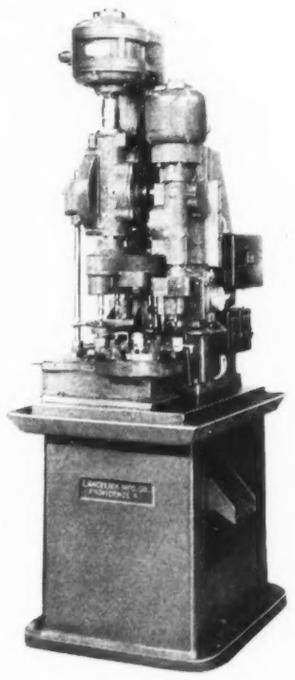
To obtain additional information on equipment described on this page, see lower part of page 798.

Recent Langelier Machines for Special Applications

A seven-spindle drilling and tapping machine of vertical design, recently built by the Langelier Mfg. Co., Providence, R. I., is here illustrated. This machine was designed for operations on the right- and left-hand stationary cutters of an electric razor. It consists of a standard No. 21 positive cam-feed automatic unit equipped with a five-spindle drill head and a No. 11 unit equipped with a two-spindle tapping head having compensating spindles. The tapping head is driven by a reversing motor.

The work fixtures are hand clamped, the front station being used for loading and unloading the work. The drills are started accurately into the work by guide bushings. This machine can be operated 900 cycles per hour continuously or as a single-cycle unit.

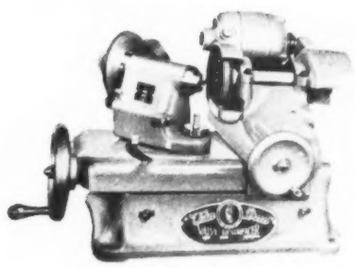
The same concern has recently built a horizontal three-way machine equipped with standard positive cam-feed units for drilling and reaming small brass castings. The three heads are interconnected electrically. Tripping is done by closing a foot switch. Carboloy tools drill and counterbore in one operation. The production rate is 450 pieces an hour. 78



Langelier Seven-spindle Drilling and Tapping Machine

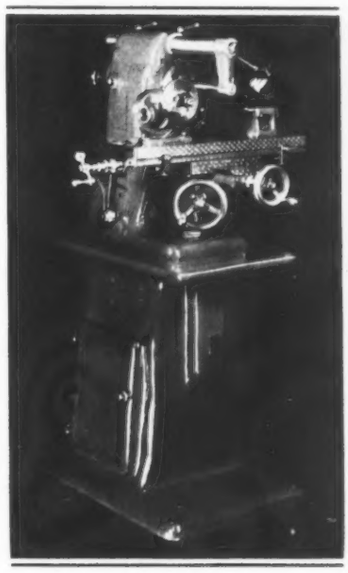
Van Dorn Valve Resurfacers

Two new valve resurfacers, one arranged for dry grinding and the other for wet grinding, have been brought out by the Van Dorn Electric Tool Co., Towson, Md., for use on all types of automobile and other internal - combustion engine valves. The dry grinder is here illustrated, the wet grinder being similar in appearance, except for a water guard provided around the grinding wheel.



Van Dorn Valve Resurfacer Made in Wet- and Dry-grinding Models

Both resurfacers are supplied in 9/16- and 5/8-inch capacities. Each one has two universal motors for independently driving the collet and wheel-spindles. The work-head can be quickly set to any valve-face angle from zero to 90 degrees. Micrometer valve stem, rocker-arm, and breaker-point grinding attachments are available. The wet-grinding valve resurfacer is supplied with a solution tank on the rear of the base. 79



Improved Cataract Precision Milling Machine

Cataract Milling Machine with Precision Preloaded Ball-Bearing Spindle

A precision milling machine designed especially for the toolroom and laboratory has been brought out by Hardinge Bros., Inc., Elmira, N. Y. This machine is equipped with the preloaded ball-bearing spindle construction that has proved successful on Hardinge precision bench lathes and hand screw machines. Eight spindle speeds, ranging from 110 to 1850 revolutions per minute, are regularly available in both forward and reverse directions. However, speeds as high as 2500 revolutions per minute can be provided.

The headstock column, overarm support, and pedestal base have been improved in design to obtain a more rugged construction and an attractive appearance. The base encloses a standard two-speed reversible motor and an endless V-belt that is connected to a four-step pulley to give eight forward and reverse speeds. Levers on the headstock operate two motor controls, one for selecting the low or high speed range and for stopping, and the other for selecting either forward or reverse rotation.

The working surface of the

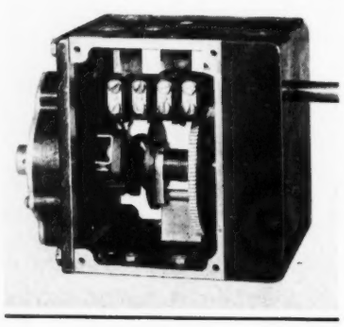
To obtain additional information on equipment described on this page, see lower part of page 798.

table is 20 by 6 inches. The longitudinal range is 13 3/4 inches; the transverse range, 6 inches; and the vertical range, 7 inches. The distance from the center of the spindle to the table in its lowest position is 7 inches. 80

G-E Feed-Measuring Limit Switch for Planer Applications

A new limit switch designed primarily for obtaining definite, predetermined amounts of feed in planer operations, has been announced by the Industrial Department of the General Electric Co., Schenectady, N. Y. The device controls the intermittent operation of the feed motor on planers, plate planers, roll grinders, or other machines on which an intermittent feed or indexing function, which must be adjustable and consistent in operation, is regularly repeated.

Essentially, the switch consists of a drive shaft connected to the feed mechanism, an indexing means for setting the amount of feed to be obtained at each individual operation, and a resetting mechanism for automatically bringing the switch to the zero-point position after each individual operation has been completed. The drive shaft operates the switch through a magnetic clutch. The indexing mechanism can be positively locked in any selected position. The switch measures 4 7/8 by 5 13/16 by 6 3/16 inches. 81



G-E Limit Switch for Planer Applications

Utility Motor-in-Head Grinder

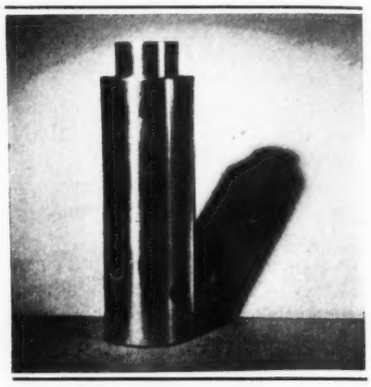
The United States Electrical Tool Co., Cincinnati, Ohio, has recently brought out a No. 500 grinder. It is designated as the "Utility Ball-Bearing Motor-in-Head Grinder," and is available in five sizes ranging from 3/4 to 5 horsepower, in three-phase, 50- to 60-cycle, 220- or 440-volt ratings. The wheel guards are of the hinged type with exhaust connections, and are adjustable for wheel wear. The tool-rests are adjustable and are mounted

Utility Grinder Brought out by United States Electrical Tool Co.

on the pedestal. A heavy extended spindle provides ample room for two operators. 82

Wayne Floating Tool-Holder

Improvements have been made recently in the floating tool-holder made by the Wayne Tool Co., Waynesboro, Pa., to further increase the accuracy and speed of reaming, boring, and tapping operations. This holder is designed to float under all conditions of service. The straight flush type illustrated permits a wider use of standard tools due to the absence of shoulders. This design also permits closer grouping of the spindles on multiple-spindle machines. It may be used either in a vertical or horizontal position on turret lathes, boring



Wayne Straight Flush Type Floating Tool-holder

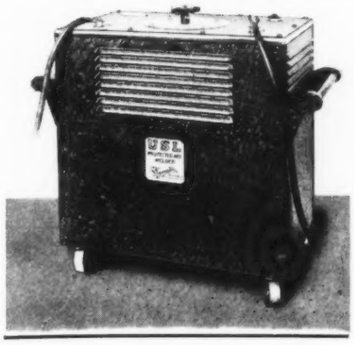
mills, drill presses, multiple-spindle drills, automatics, and similar equipment.

The type intended for straight-shank tools is provided with a socket bushing having a front section equal in diameter to the socket shank. A hollow-head setscrew in this section serves to tighten the tool in the bushing. These holders are available for taper or straight-shank tools. There are two general types. The flush type holder is for horizontal use in turrets of all kinds. Socket bushings for these holders can be made straight or tapered to fit any turret. A second type has been developed for vertical use in drill presses or multiple-spindle drills. The elimination of overhang is an important feature of this type. A sturdily designed holder may be had for boring mill use to accommodate boring-bars, as well as reamers. drills, and taps. 83

Owen-Dyneto Transformer Type Arc Welder

An alternating-current welding machine, known as the "USL Protected Arc AC Welder," is being placed on the market by the Owen-Dyneto Corporation, Syracuse, N. Y. This welder is designed for connection to any standard voltage or frequency power line. It is rated at 150 amperes and has a range of from 30 to 280 amperes output. The open-circuit current of 55 volts maintains 20 to 30 volts across

To obtain additional information on equipment described on this page, see lower part of page 798.



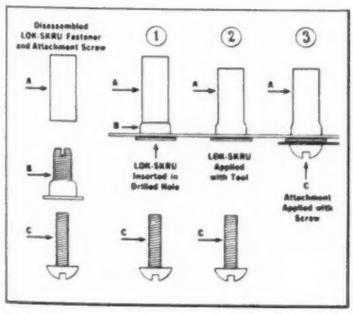
Owen-Dyneto Transformer Type Arc Welder

the arc. Any commercial alternating-current welding rod from 1/16 to 1/4 inch in diameter can be used. The welder is built to give thorough penetration on heavy work, yet it can be adjusted to meet the lower heat requirements for welding thin sheets. The total weight of the welder is 190 pounds. 84

Dill "Lok-Skru" Fastener for Sheet-Metal Assembly

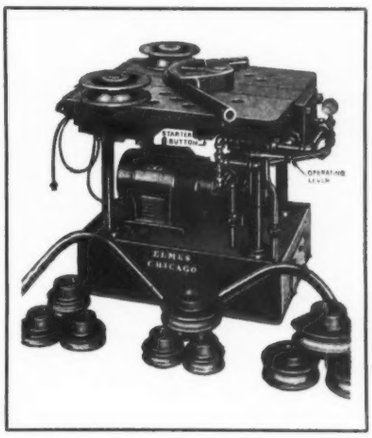
A patented fastener designed for use as a blind rivet for assembling or attaching sheet-metal parts in the construction of aircraft, is now being produced by the Dill Mfg. Co., 694 E. 82nd St., Cleveland, Ohio. This fastener, known as the "Lok-Skru," consists of two parts, *A* and *B*, as shown in the accompanying illustration.

With the aid of a specially designed tool, a workman can insert the fastener in a drilled hole,



Diagrams Indicating Method of Using Dill "Lok-Skru"

as shown in view (1), and draw the part *A* down over the enlarged portion of part *B*, so that the end of part *A* is expanded and tightened against the back side of the sheet metal to which it is being attached, as indicated in view (2). A threaded hole in part *B* permits a screw *C* to be used as shown in view (3) for attaching or assembling purposes. The attaching screw is securely set by a locking device that is not affected by oil or heat. 85



Elmes Table Type Hydraulic Pipe-bending Machine

Elmes Hydraulic Pipe-Bending Machine

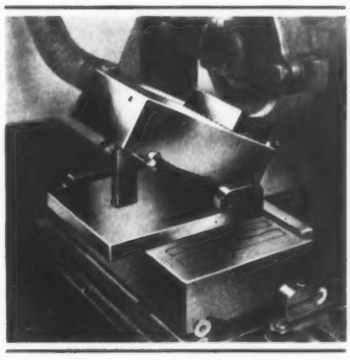
The Charles F. Elmes Engineering Works, 222 N. Morgan St., Chicago, Ill., have recently placed on the market a hydraulic table type pipe-bending machine. This machine is designed to handle a wide variety of work. It is of welded steel construction and is capable of withstanding hard wear and service. All moving parts are accurately machined and pressure lubricated. The table top and rollers have a smooth finish and the pin-holes are so located as to permit bending the pipe to any desired angle. A sensitive four-way valve gives instant and accurate control of the center pin movement. The automatic safety valve prevents overloading.

The fully enclosed fan-cooled motor, with a rotary vane type pump on the end bell, is mounted on top of the welded steel oil reservoir. All pipes leading to the oil reservoir are welded to the top plate. An air filter is located in the oil filling hole. 86

New Single-Angle Magna-Sine

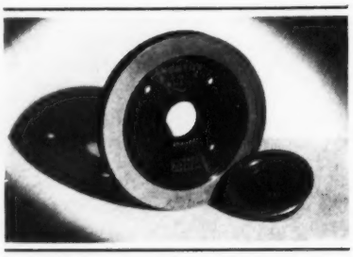
The Omer E. Robbins Co., 635 Mt. Elliott Ave., Detroit, Mich., which recently took over the manufacture and sale of the Magna-Sine described in March, 1937, MACHINERY, page 438, has added a popular-priced model to the line. This model differs only slightly from other single-angle Magna-Sines. It is limited to use with 110-volt current. Certain parts that were formerly made of hardened steel have been replaced with steel castings but the general design remains the same.

As will be seen in the accompanying illustration, the new model consists of a baseplate to which a magnetic chuck table is hinged. This table can be accurately tilted to any angle by employing gage-blocks between the top of the baseplate and a cylindrical bar which extends the full width of the hinged table on the under side. The distance between the centers of the pivot hinge and the gage-block contact bar is 5 inches. This device is suitable for use in grinding, lapping, honing, and other operations and in the inspection of finished work. The work is held securely on the table by merely turning a switch. 87



New Model Magna-Sine Brought out by the Omer E. Robbins Co.

To obtain additional information on equipment described on this page, see lower part of page 798.



Norton Diamond Wheel with Metallic Bond

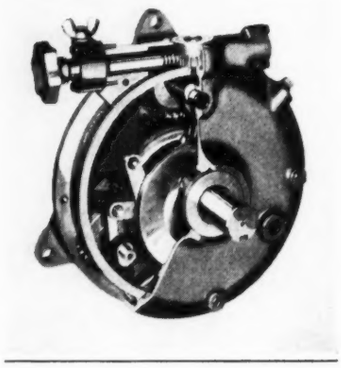
Norton Diamond Wheel with Metallic Bond

As a result of extensive research work, the Norton Co., Worcester, Mass., has developed a new type of diamond wheel which embodies the use of a metallic bond, and on which patents have been granted. The diamonds used in this wheel are actually embedded in solid metal, the entire rim being a homogeneous piece. This eliminates joints between the diamond impregnated grinding surface and the rim, which might cause premature breaking away of the expensive abrasive material. The metal used is a special alloy that holds the diamond particles securely yet allows just sufficient wear to keep the wheel in a free-cutting condition. 88

Morse Variable-Speed Control Unit

A simple positive mechanism for governing the speed of output shafts through an infinite number of variations within its range, has been brought out by the Morse Chain Co., Ithaca, N. Y. With the input shaft operating at the recommended speed of 180 revolutions per minute, the control can be quickly adjusted to deliver any speed desired from 1 1/2 to 40 revolutions per minute through the low-speed shaft. A dial is provided which indicates the exact speed setting at all times. The unit is designed primarily for driving machine feeds and can be easily attached to any machine frame with three bolts.

The accompanying illustration shows the construction of the variable-speed control. The input shaft is made with an integral cam. Operating against this cam are the hardened and ground alloy steel rollers which transmit the driving action to the clutches through links connected with hardened pins and graphite-bronze bushings. Three high-torque clutches operated by the link-and-cam mechanism function with a ratcheting movement to rotate the pinion gears, which,



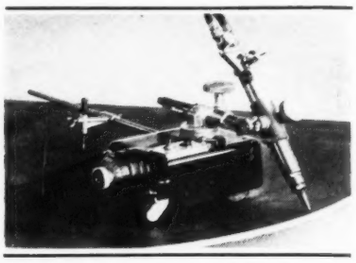
Morse Variable-speed Unit Developed for Driving Machine Feeds

in turn, drive the mating gear machined integral with the low-speed shaft. 89

"Radiagraph" Gas Cutting Machine

The Air Reduction Sales Co., 60 E. 42nd St., New York City, has recently added a light-weight No. 10 Radiagraph gas cutting machine to their line of equipment. This machine will cut bevels up to 45 degrees. It will cut square edges along straight lines of any length desired and complete circles up to 85 inches in diameter by using the radius-rod and center point.

The machine has a cutting speed of from 4 to 60 inches per minute, free-wheeling for easy lining-up to the work, simplified horizontal and vertical torch adjustment, and completely enclosed working parts. It will operate on



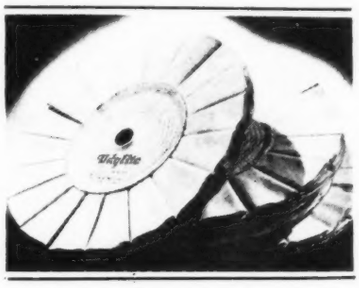
"Radiagraph" Gas Cutting Machine

110-volt alternating or direct current. As the machine weighs only 41 pounds, it can be easily carried from job to job. 90

Udylite "Masterfold" Buff

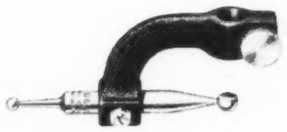
The Udylite Co., Detroit, Mich., has just brought out a "Masterfold" buff which is designed for faster cutting, longer buff life, and better finish. The cloth employed in this buff is folded in such a manner as to present a large number of edges to the work that have a cutting instead of a rubbing action. This construction also provides air spaces between the cloth plies which dissipate heat generated by the friction resulting from pressure of the buff on the work.

This buff is designed for use on all metals and plastics and can be employed on both automatic buffing machines and hand-operated lathes. It is produced in a variety of types which vary according to the density and treatment of the cloth. The buffs are available in all standard diameter and arbor hole sizes. 91



Udylite "Masterfold" Buff for Metals and Plastics

To obtain additional information on equipment described on this page, see lower part of page 798.



Brown & Sharpe Hole-testing Attachment for Dial Indicators

Brown & Sharpe Attachments for Dial Test Indicators

The Brown & Sharpe Mfg. Co., Providence, R. I., has recently brought out two attachments designed to adapt dial indicators for testing internal and other surfaces which cannot be reached with the spindle of the dial gage. The attachments can be easily and quickly applied to dial gages and held firmly in position by knurled clamping screws. Looseness or play in the arm can be eliminated by means of a fulcrum screw. The hole-testing attachment No. 729A is particularly suited for use in holes to a depth of 1 11/16 inches, while attachment No. 729B, shown in the illustration, is intended for use in shallow holes. The latter attachment will enter a hole to a depth of 13/16 inch. 92

High-Speed Resinoid-Bonded Snagging Wheels

High-speed resinoid-bonded grinding wheels with two circular steel flanges permanently embedded and bonded into the wheels around the center hole, have been brought out by the Abrasive Co., Grinding Wheel Division of Simonds Saw & Steel Co., Philadelphia, Pa., for use in rough-snagging operations. These wheels are adapted for use in foundries and steel mills for cleaning castings and billets on swing frame and floor stand grinding machines.

The metal inserts are designated as "Red Streak Flanges." Each flange is an independent unit in perfect alignment with the other flange and provides a flat circular steel surface that is flush with the side of the grinding wheel and surrounds the large center hole. It also provides a lining for a portion of the center hole and extends into the grinding wheel itself.

Advantages claimed for this construction are reduced wear on the mounting flanges and a center hole that is held to size within close tolerances, thus providing a more perfect fit between the wheel and the spindle mounting. Wheels with "Red Streak Flanges" are now available in sizes up to 24 inches in diameter by 3 inches thick with a 12-inch center hole. 93

High-speed Grinding Wheels with "Red Streak Flanges"

Themac Portable Toolpost Grinders

Recent additions to the line of Themac portable toolpost grinders, made by the McGonegal Mfg. Co., 228 Orchard St., East Rutherford, N. J., include a Type J-30 which is an improvement over the Type J-3, and a type J-40 which is an improvement over the Type J-4. The Type J-30 takes a 4-inch wheel and is equipped with a 1/3-horsepower universal motor for operation on alternating and direct current. The Type J-40 grinder is of the same appearance but takes a 5-inch wheel. This model, which is here illustrated, is equipped with a 1/2-horsepower universal motor.

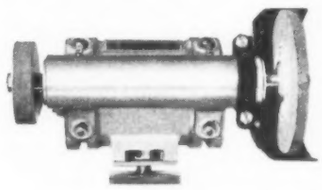


Fig. 1. Themac Portable Toolpost Grinder Made in Two Models

Both grinders can be supplied with a new type of pencil wheel that can be attached directly to the end of the spindle to enable both internal and external grinding operations to be performed.

Five spindle assemblies, which are shown in Fig. 2, can be supplied for use with both grinders. The assembly at *A* is intended for handling pencil wheels; the assembly at *B* is for external grinding with wheels up to 5 inches in diameter and for internal grinding with pencil wheels to a depth of 2 5/8 inches; the assembly at *C* is for internal grinding with a 1-inch wheel to a depth of 2 1/16 inches or with pencil wheels to a depth of 3 1/8 inches; the assembly at *D* is for external grinding with wheels up to 4 inches in diameter or for internal grinding

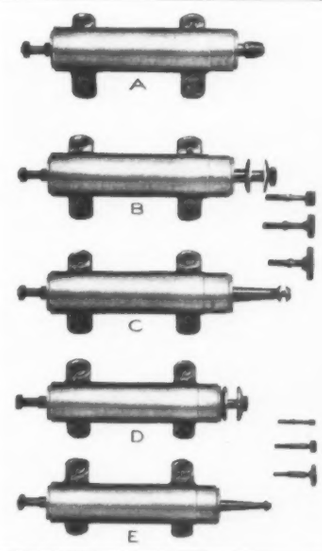
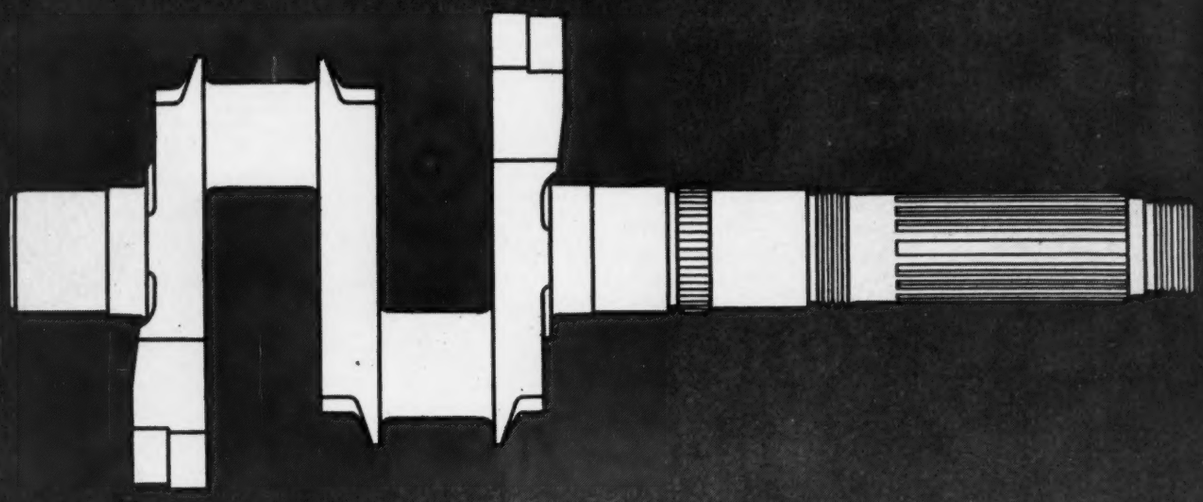


Fig. 2. Spindle Assemblies Applicable to Themac Grinders

To obtain additional information on equipment described on this page, see lower part of page 798.



Aircraft makers find in the Brown & Sharpe line . . . **modern** machine tools that give the **accuracy and productive capacity** needed for **profitable manufacture**

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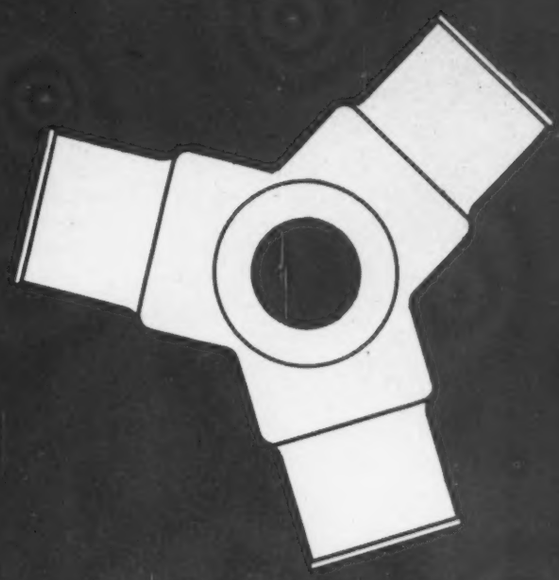

Milling Machines

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Plain — Vertical

Grinding Machines

Universal — Plain
Surface — Tool

Screw Machines

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Investigate the advantages of using Brown & Sharpe Machine Tools!

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with pencil wheels to a depth of 2 inches; and the assembly at *E* is for internal grinding with recessed wheels up to 7/8 inch diameter to a depth of 2 inches or with pencil wheels to a depth of 3 inches. 94

Jacobs Drill Chuck Developed for Use in Aircraft Industry

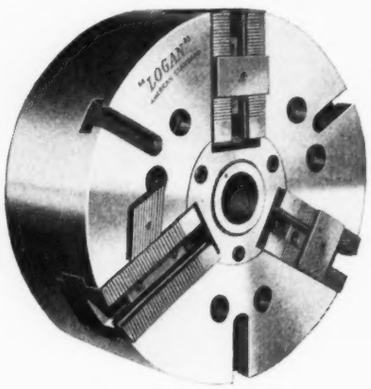
A special drill chuck, known as the No. 7 or 7B "Aero," designed to meet the particular requirements of aircraft manufacturers, has been brought out by the Jacobs Mfg. Co., Hartford, Conn. These chucks are usually furnished on portable tools for use in drilling rivet holes. They are of the heavy-duty type having approximately the same dimensions as the regular 1/4-inch plain bearing models made by this company, although the capacity is from 0 to 5/32 inch. 95

Jacobs Drill Chuck Developed for Use in Aircraft Plants

Logan Power-Operated Chucks

A new line of power-operated chucks designed to conform to the specifications of the American Standards Association, as approved in November 1936, has been brought out by Logansport Machine, Inc., Logansport, Ind. The basic features of design and construction found in previous chucks of this company's manufacture have been incorporated in the new line, which is designed to give long life, a high degree of accuracy, and operating efficiency in heavy-duty service.

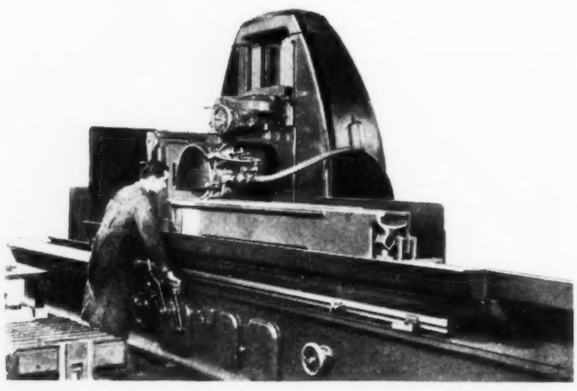
A feature of these chucks is the combination of strength and rigidity with compactness and light weight. Positive pressure lubrication is provided for all working parts and all models equipped with pilot bushing supports are completely sealed against dust, abrasives, cuttings, or other foreign matter. These chucks can be mounted on American Standard spindle noses, being attached directly on Types A and B spindles, and through the use of an adapter on Type C. 96



Power-operated Chuck Brought out by Logansport Machine, Inc.

Grinding Hardened Machine Ways

With the increased use of hardened machine ways, the problem of finishing these hardened surfaces assumes considerable importance. One method of handling this work is shown in the accompanying illustration. The large grinder is being used to finish the flame-hardened ways of a machine bed, grinding the V- and flat-way surfaces accurately within extremely close limits. A wheel truing device mounted on the wheel-slide is employed to true both sides of the wheel to the angles required for grinding the V-way surfaces This grinding machine is built by the Mattison Machine Works, Rockford, Ill. Tables are available for most way-grinding jobs.



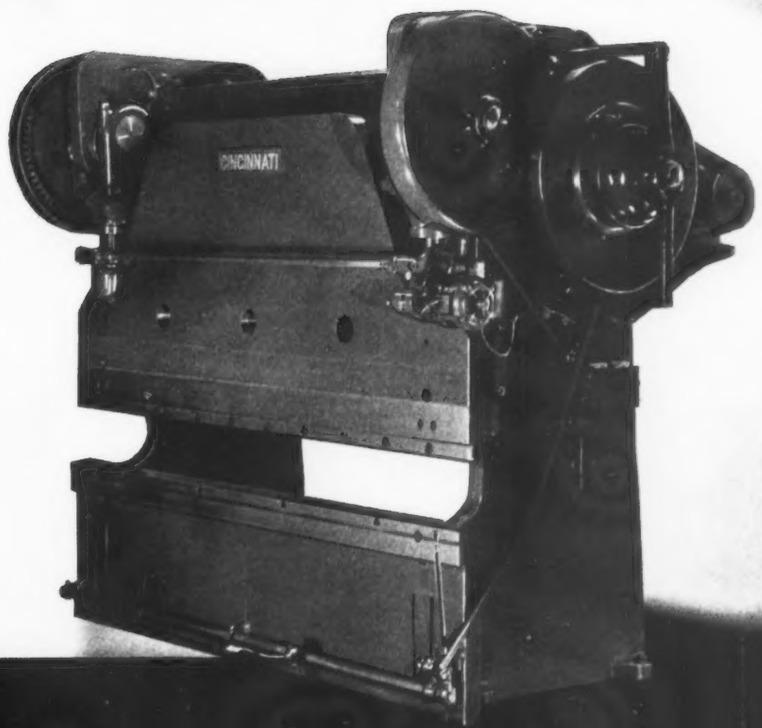
Grinding the Flame-hardened Ways of a Machine Bed

Meeting of Resistance Welder Manufacturers

The Resistance Welder Manufacturers Association, with headquarters at 505 Arch St., Philadelphia, met at Detroit, Mich., June 9, to develop a program to improve conditions throughout the industry. A Committee on Standards, under the chairmanship of John D. Gordon of the Taylor-Winfield Corporation, is working on standardization in the welding industry. Standard transformer specifications are being studied by a committee under the chairmanship of H. V. Beronius of the Welding Machines Mfg. Co.

To obtain additional information on equipment described on this page, see lower part of page 798.

For the "Sky Ship" . . . . .
Corrugating 12 ft. Dural sheets
. . . edges must line up after
forming . . . a striking example
of the performance of
Cincinnati Press Brakes. . . .



THE CINCINNATI SHAPER COMPANY, CINCINNATI, OHIO

SHAPERS · SHEARS · BRAKES

Unusual Application of Lifting Magnet

At the plant of the Ohio Electric Mfg. Co., Cleveland, Ohio, one of the company's own make of lifting magnets is applied in an unusual manner for lifting sheet steel bundles. The company tells of its experience with this method of handling sheet steel as follows: "Like many other users of sheet steel, we have deliveries made in bundles which we unload and handle by means of an electric hoist on a monorail. For years we used chains and could not avoid damaging a number of sheets at each lift. To unload a shipment of 20 tons required the labor of three men for approximately two hours.

"Some time ago we adopted a method of packing indicated in the illustration, the bundles being fastened together with three straps resting directly on the sheets on the top and enclosing three supporting planks underneath. This method of packing keeps the bundles flat and makes it easier to attach the clamps for lifting. A drawing is sent along with each order to the mills, to indicate how the sheets are to be bundled. This method of packing does not add to the price of the steel. The bundles measure 34 inches wide by 100 inches long and have an average weight of about 5000 pounds.

"With a 21- by 83-inch magnet arranged as shown, one man unloaded 27 tons in thirty-nine minutes, including the time required to take the picture. The magnet illustrated can handle up to 12,000 pounds."

Exhibit of Steels of Today and Tomorrow

On June 16 a new exhibit was opened at the New York Museum of Science and Industry in Rockefeller Center, New York City. The exhibit is sponsored by the Ludlum Steel Co., Watervliet, N. Y., and the Allegheny Steel Co., Breckenridge, Pa., both companies specialists in the alloy steel field. The exhibit is a most unusual one in that emphasis is placed on the great number of complex steel alloys that are now being employed for almost every conceivable purpose in industry and in every-day life. Contrary to custom, the exhibits are mostly those of consumption and application rather than of production. Fabricating devices and welding methods are shown, as well as operations in the process of manufacture.

Attention is called to the latest developments of the sponsoring companies, some of which are hardly beyond the laboratory stage. As an example in this class is the Ludlum Steel Co.'s procedure of coloring stainless steel—not mere applied coloring, but coloring in the steel itself, which increases the corrosion resisting and stainless properties. The color ranges in fine gradations from light yellow to a slate gray.

Considerable space is also devoted to the new tool steels and their use in industry. Nitralloy, stainless tubing and wire, and Allegheny metal are arranged in exhibits which bring home the fact of the tremendous advance in the steel industry. A talking motion picture in natural colors is in continuous operation.

The H. A. Smith Machinery Co. of Syracuse, N. Y., Dealers in Machine Tools and Shop Equipment, Staged a Machine Tool Show on Their Exhibition Floor for an Entire Week During the Middle of June. About Forty Machine Tools, Representing the Products of Some Twenty-five Machine Tool Builders, were Exhibited in Operation. The Exhibit was Unusually Well Attended by Manufacturing Executives, who Showed a Great Deal of Interest in the Equipment on Display

Be first in your industry to take full advantage of this

NEW

2½' ARM Super-Service RADIAL

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7½" Column 1 H. P. Motor High Speed Sensitive Radial Drill

The Cincinnati Bickford Tool Company presents a new Radial Drill, for manufacturers whose work includes much small drilling in fairly large quantities which would otherwise be handled on large upright drills or on less efficient, belt driven radials. Advantages of size, economy, ease of handling, power and floor space requirements are apparent and, incidentally, this is probably the only radial offering a simplified head and the advantages of pick-off gears. Standard Super-Service quality includes automatic oiling —anti-friction bearings— multiple splined integral key shafts—head mounted on ball bearing rollers and hardened steel armway—3 rates of power feed controlled by single lever by means of sliding chrome nickel steel gears—3 spindle speeds similarly controlled by direct reading lever and sliding gears.

This new Super-Service Radial will pull a 1" drill in cast iron, or a 3/4" drill in steel. Further particulars upon request.

THE CINCINNATI BICKFORD TOOL CO.
OAKLEY CINCINNATI OHIO. U.S.A.

Associated Machine Tool Dealers Study Selling Problems

FORMER attendance records were broken at the unusually successful spring convention held by the Associated Machine Tool Dealers of America at Dearborn, Mich., on May 23 and 24. Problems of outstanding importance to machine tool salesmen, as well as to the industry as a whole, were discussed by a number of competent speakers.

In his keynote address, A. G. Bryant, president of the association, focused attention on two topics of major interest. First, "How may the general level of machine tool activity be stabilized?" and second, "How can we do a better job of selling the products of our manufacturers?" Mr. Bryant pointed out the wide fluctuations in the machine tool industry from heights of prosperity to periods of operation at substantial losses. He stressed the desirability of stabilizing the industry as far as possible and emphasized the fact that "too large a proportion of the machines sold during the past generation has been for expansion rather than replacement, and it is apparent that we must undertake the analysis of the market existing for replacement if we are to continue to grow as an industry, and particularly if we are to make much progress in the stabilization of sales volume in selling machine tools."

Mr. Bryant indicated a potential large demand for replacement purposes in the statement, "The fact is, however, that at the present time a least two-thirds of all machine tools in use in this country are more than ten years old. If we accept the statement that the average age of obsolescence in the design of machine tools at present is about seven years, we can realize the economic necessity for the wholesale replacement of equipment now in service."

George Habicht, of the Marshall & Huschart Machinery Co., outlined the essentials which should be followed by machine tool salesmen, emphasizing the importance of a thorough analysis of the buyer himself, as well as of his particular requirements. A method of following the activities of salesmen without the necessity of elaborate systems was explained by G. J. Hawkey of the Cleveland Duplex Machinery Co., Inc., who also stressed the importance of the home office rendering assistance to the salesmen. Jack C. Carlton, of the Calco Machinery Co. and the Carlton Machine Tool Co., emphasized the fact that a splendid opportunity is now afforded to dealers to thoroughly inspect the equipment of buyers in order to ascertain the possibility of developing replacement business.

Developments in Europe were covered by Hugo Stokvis, president of R. S. Stokvis & Zonen, Rotterdam, Holland, and by N. P. Lloyd of Lloyd & Arms, Inc. An interesting comparison between the English and American machine tool industries was made by E. H. Jones, of E. H. Jones Machine Tools, Ltd. Greetings from the National Machine Tool Builders Association were extended by Howard W. Dunbar, president of that organization.

Other speakers included W. J. Cameron of the Ford Motor Co., whose theme was "Machines Create Employment"; H. G. Weaver, director of Customers' Research Division of the General Motors Corporation, who explained the manner in which the consumer assists in the future planning of products; and David A. Wallace, president of the Chrysler Division of the Chrysler Corporation, who commended the machine tool industry for its part in raising the standard of living and suggested improvements that would increase the utility and efficiency of machine tools.

How Industry Has Pioneered Social Security

In a recent address entitled "Pioneers of Employe Security," by William G. Marshall, vice-president of the Westinghouse Electric & Mfg. Co., it was pointed out how more than a generation ago enlightened industrial leaders developed social security plans, many of which were more carefully thought out and of greater value to employes than the plans that have now been incorporated into the laws of the nation and many states.

Several of the outstanding manufacturing companies of the United States had successful pension plans as far back as 1908, group life insurance since 1915, unemployment insurance since 1930, profit-sharing in one form or another since 1919, vacations with pay for both wage and salaried employes since 1913, and collective bargaining as far back as 1919.

In view of this record, Mr. Marshall declared, industry is right in protesting the notion and innuendo "that all that is good and worthwhile has been, in all cases, forcibly drawn from an unwilling, obstinate, and reactionary management; and that all that is undesirable and worthless—wages, hours and working conditions that are unfair and unjust—have been forced upon a defenseless generation of workers.

"Industrial management is not protesting against the principle of labor organization. It is not protesting against establishment of hours and working conditions determined after careful study. It is not protesting payment of the highest wages commensurate with what is possible in the industry, and in tune with economic conditions.

"Industry is, however, protesting the theory and the assumption that the very foundation of the working relationship between a workman and the man or company by whom he is employed is founded upon strife and conflict.

"For two years now, demands and counter-demands for wages, hours, and working conditions have been front page news. The public thinks of working conditions in terms of light, heat, sanitation, and safety; it often ignores the importance of such other benefits as retirement plans, group life insurance, vacations with pay, profit sharing and wage incentive plans, unemployment insurance, savings and thrift plans, and collective bargaining.

"Has the public been properly informed of the comprehensive and successful plans that have been quietly operating among millions of workers for more than a generation? It would seem that industry had left all this to those who believe they have something to gain by capitalizing on it as being of very recent origin."